Local Area Network (LAN) Overview

Network Plan:

Users' Needs/Goals	+	Available Technology	=	Application Example
• Geographical		• Sources of Technology		• IBM Token—Ring
• Physical		• Terminology		• DEC Ethernet
• Logical		• Standards		• Ungermann—Bass Net/One
• Financial		• Interfaces		• Corvus Systems Omninet
• Control		• Internetwork Strategies		• Applitek UniLAN
• Growth				• Novell Netware
				• 3Com Ether Series and 3+Series

Local Area Network (LAN) Implementation

- Cable Type
  - Twisted Pair Cable
  - Coaxial Cable
  - Optical Fiber Cable
- Network Topology
  - Star
  - Bus
  - Ring

Local Area Network (LAN) Implementation

- Transmission Technique
    - Baseband
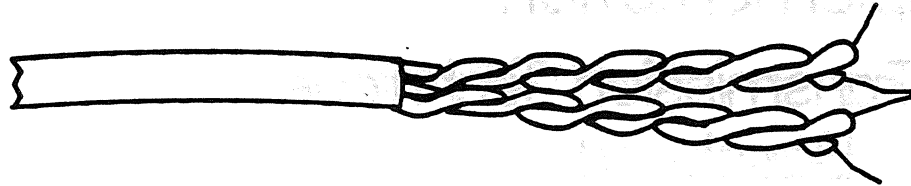   - Broadband
    - Fiber Optic
- Access Method
    - Carrier Sense Multiple Access (CSMA) with Collision Detect (CD).
    - Token — Passing
    - Time Division Multiplexed (TDM) Slots
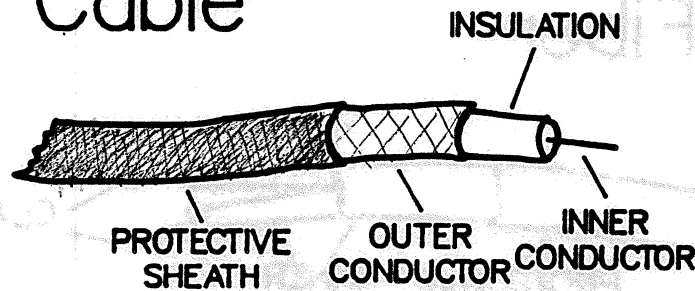
Twisted Pair Cable

- Already Installed in Many Buildings
- Inexpensive, Easily Installed, Simple Interface
- Data Rate Is 1 Mbps Over 100 m.
- Is Vulnerable to Electrical Noise

Manufactured in every conceivable shape, size, and configuration, the copper wire provides a universal medium for the transmission of electrical signals. It basically consists of two or more insulated copper strands that act as signal conductors.

- Since computers produce digital electrical pulses, twisted copper wire is an ideal low cost medium for direct data transfer. It is easy to install and often is an obvious choice for low speed networks.
- Because of its low resistance to electrical noise, twisted copper wire is not suitable for very high speeds or long distances without amplification of the signal.
    - Performance can be improved by using balanced twisted pairs screening the cable, but unfortunately such cable is much more expensive.

Coaxial Cable

INSULATION

PROTECTIVE SHEATH **OUTER CONDUCTOR** **INNER CONDUCTOR**

- More Expensive Than Twisted Pair Wire
- More Complicated Interface
  - Needs Transceivers, Taps, etc.
- Data Rate is 10 Mbps Over Several Kilometers.
- Has More Resistance to Electrical Noise.

Coaxial cable, with central conductor, surrounded by a circular outer conductor, and separated by layers of insulation, is a higher performance medium than twisted copper wire.

- Cable is available in varying thicknesses, and because of its use in the television industry, the cost is comparatively modest. Fittings to tap and branch the cable are readily available.
- Because of the arrangement of the two conductors, the signal sent is far less affected by noise, and cable runs of several kilometers can be considered without signal amplification.
  Coaxial cable can be broadly subcategorized into two types:
  - High capacity systems using CATV (community antenna television) cable, which is semirigid but carefully constructed to give high performance with much immunity to electrical noise.
  - Smaller diameter coaxial cables, as used by many systems, such as Ethernet, are slightly less vigorous in specification but much more flexible during installation.

Optical Fiber Cable
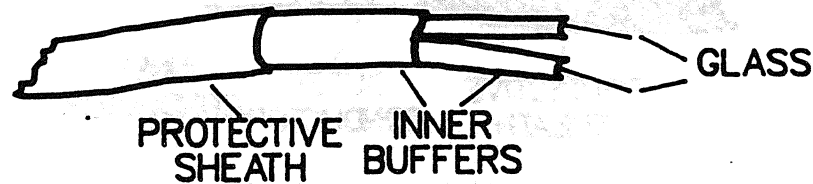
- Most Expensive Medium for LAN Use, but Very Attractive as Microwave or Trunk Substitute.

- Highest Data Rates (20 Mbps) Over Fairly Long Distances (Several Kilometers).

- Point—to—Point (Backbone) Technology

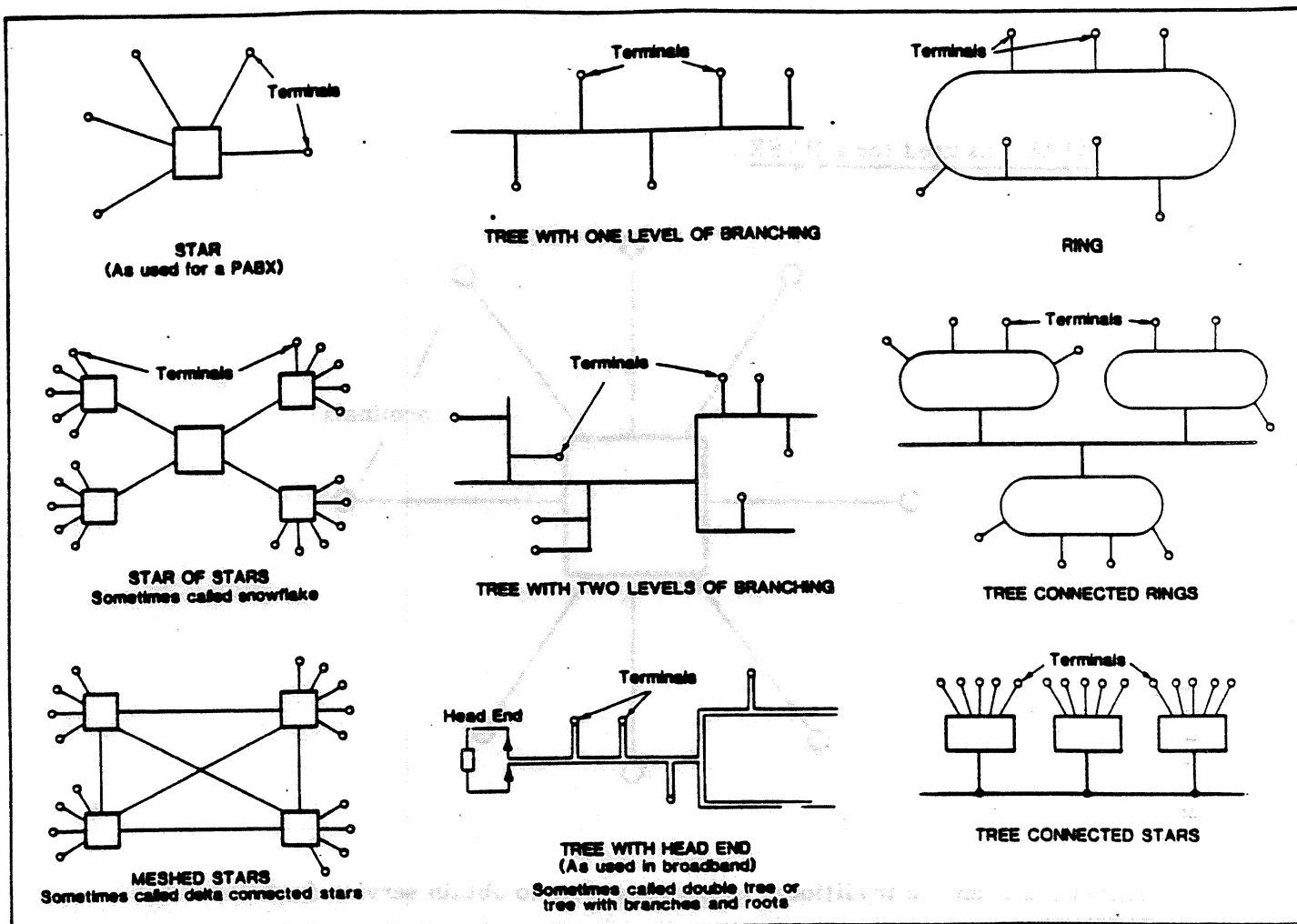- Requires Optical Repeaters and Taps that Are Expensive and Complex.

Fiber optic cable has many attractive features that make it an obvious contender for the carrying medium of the future.

These include;
- Small physical size.
- Immunity to electrical and radio frequency interference.
- Very long cable runs with no signal amplification.
- Immune to moisture and most chemical environments.
- Low weight.
- Very high carrying capacity up to gigabits per second.
- Suitable for very high speeds.
- Resistant to temperature variation.
- Greater transmission security.

Fiber optic cable currently suffers from some severe disadvantages that may take considerable time to be eradicated;

- Because they are difficult to split, tree structures are very expensive.
- Costs are still high for good quality fiber but are falling.
- Very little experience exists with commercial products.

STAR
(As used for a PABX)

TREE WITH ONE LEVEL OF BRANCHING

RING

STAR OF STARS
Sometimes called snowflake

TREE WITH TWO LEVELS OF BRANCHING

TREE CONNECTED RINGS

MESHED STARS
Sometimes called delta connected stars

TREE WITH HEAD END
(As used in broadband)
Sometimes called double tree or
tree with branches and roots

TREE CONNECTED STARS

LOCAL AREA NETWORK TOPOLOGIES

The allowable shape of a network provides a useful guide to the features it offers.

- Ideally, topologies should be adaptable to match the information flow in an organization.
  - Often information flow patterns are very complex, particularly if more than one building on the same site is involved.
  - Some information flow patterns can be matched by several different topologies, others can only be matched by a combination of topologies.
- In the majority of cases, other considerations will take precedent over topology in network selection, but extreme cases will dictate a particular solution.
  - Topologies are very malleable and flexible and can mimic other topologies, though this usually involves extra cable installation costs and can be at the expense of a loss of performance.

STAR (as used for a PABX)
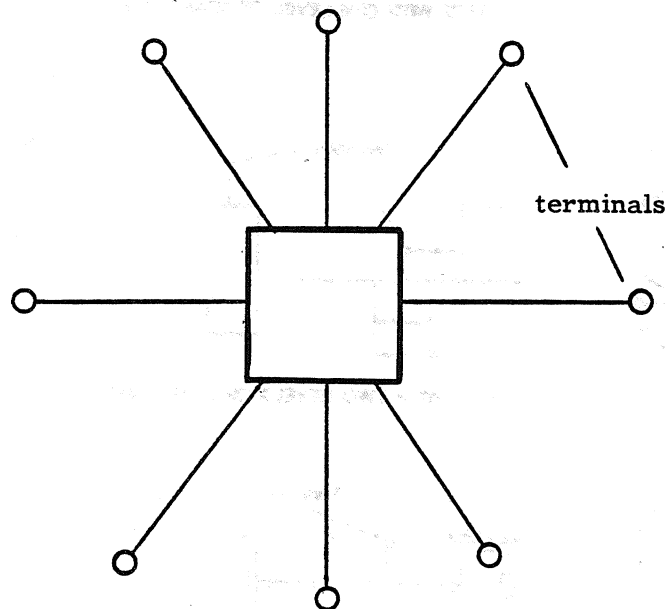
terminals

Stars have been the traditional topology, set up to obtain service from a central resource.

- With stars, terminals and other devices are connected to a central point via point to point or multidropped circuits.
   - Star topologies often develop into a complex of connecting stars.

  The advantages often perceived for stars are the following:
    - Simplicity of control.
    - High reliability; failure at a remote node does not affect the remainder of the network.
    - Flexibility in adding or deleting devices.
    - Ability to handle separate speeds, codes, etc., on each link.
    - Well-understood techniques, with standard hardware and software available.

  Stars have certain disadvantages:
    - External nodes can not communicate directly, even if geographically adjacent, without going through the center of the star.
    - Central star failure incapacitates the entire network.

- Stars are usually supported by a computer processor if the traffic flow is largely to and from a central resource. PABX systems or message switches are usually used to control stars if most traffic is switched from one external node to another.

TREE TOPOLOGY
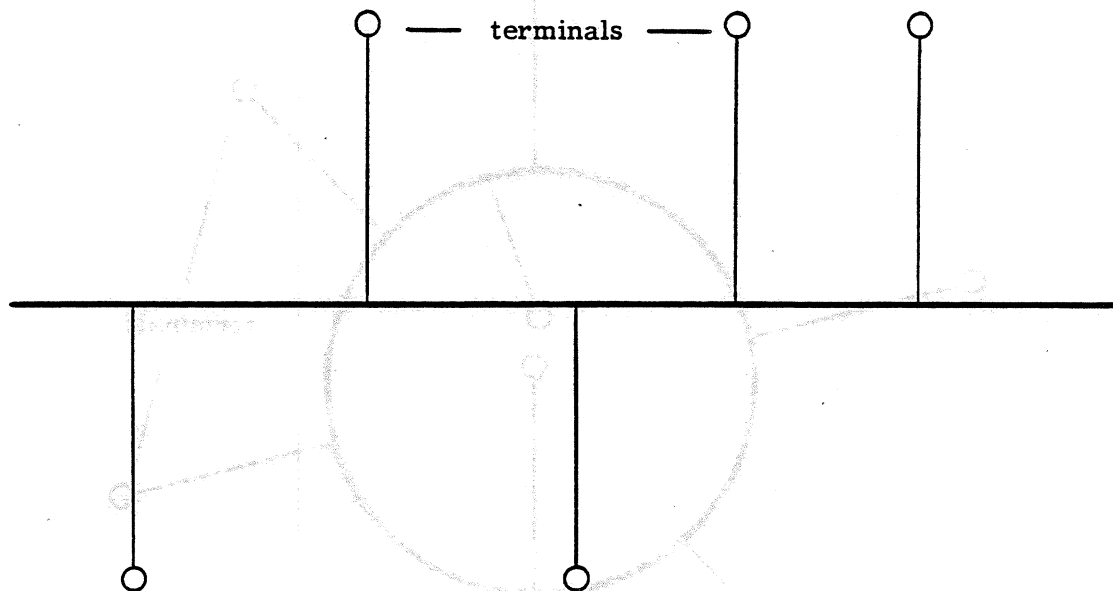
Tree networks are open-ended, with a cable providing a common bus over which information is broadcast.

- A key issue with tree networks is controlling access to the bus. Although many alternative methods exist, the most important access methods are contention systems.
    - Attached interfaces listen to the line and only transmit if the circuit is not being used.
    - Techniques must exist to resolve collisions caused by more than one interface transmitting simultaneously.

- Tree structures are relatively simple to design and install, easy to use, and surprisingly reliable and hence have found favor with many network suppliers.

- A tree structure, branching from a single head end, is a favorite topology for high capacity networks.
    - Many broadband systems use this topology and build on technologies developed for short-haul television services.

RING TOPOLOGY
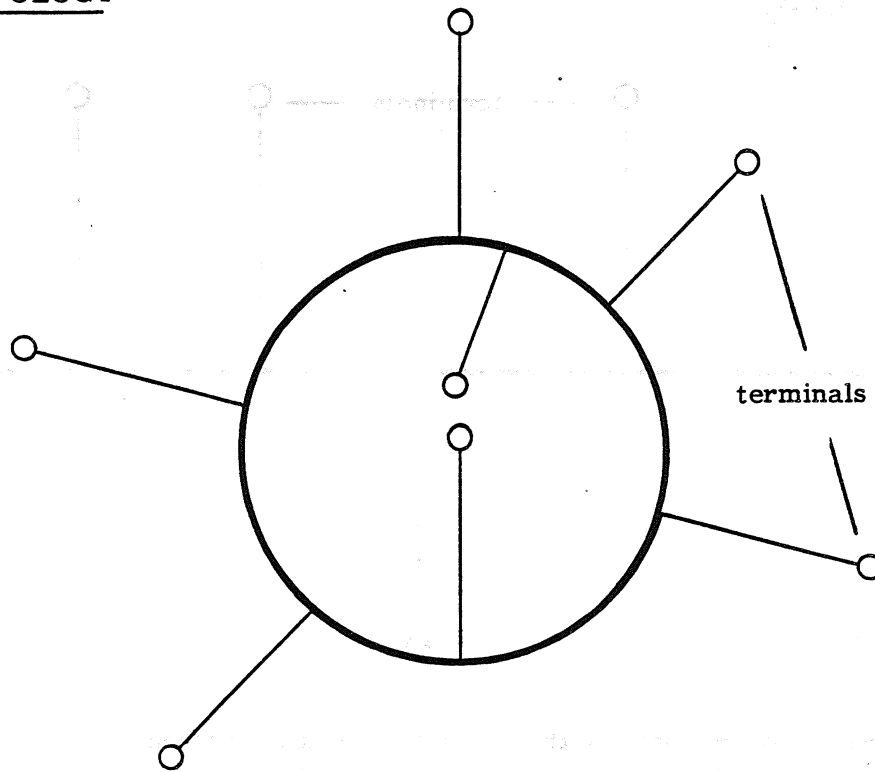
terminals

. In principle, using a ring to interconnect terminals and nodes offers two paths
between any work station and the service it wishes to access.

- However, most proprietary systems are implemented with a
  unidirectional data flow. In some systems the second direction
  of flow can be exploited in certain failure situations.
- Rings must provide the multiplexing of message path, as many
  nodes share the same physical cable.
    - Multiplexing can be effected by bandwidth (channel) partitioning
      or by some form of time allocation.
- A strength of ring systems is that they are relatively easy to control
  and offer good facilities to detect the correct errors.
    - Messages circulating completely around a ring can be fully
      monitored.
- Rings require quite sophisticated access logic, which is not expensive.
  The access logic can be shared.
    - It is usual with rings to seek to attach several devices at each
      access point.

Transmission Techniques
Baseband

| One Channel of Information |

- Coaxial Cable
- Single Cable
- Data Only
- Digital Signal

Transmission Techniques
Broadband

Can Be Used for Data, Voice, or Video
Can Be Used for Data, Voice, or Video
Can Be Used for Data, Voice, or Video
Can Be Used for Data, Voice, or Video
Can Be Used for Data, Voice, or Video

- Coaxial Cable
- Multiple Channels
  (More Bandwidth than Baseband)
- Data, Voice, or Video May Be Transmitted
- Analog Signal
- Data Channels Can Communicate with Each Other Over Interchannel Bridges.

Transmission Techniques
Fiber Optic

One Channel of Information

- Optical Fiber Cable
- Single Channel
  (More Bandwidth than Broadband)
- Can Be Configured for Multiple Channels
- Data, Voice, and Video May
  Be Transmitted
- Light Signal
- Very Resistant to Noise

Carrier Sense Multiple Access (CSMA)

- Distributed Control
- Probabilistic Delay
- Asynchronous Interactive Traffic
- Performance Degrades as Load Increases
- Ethernet Strategy

LISTEN, THEN TRANSMIT
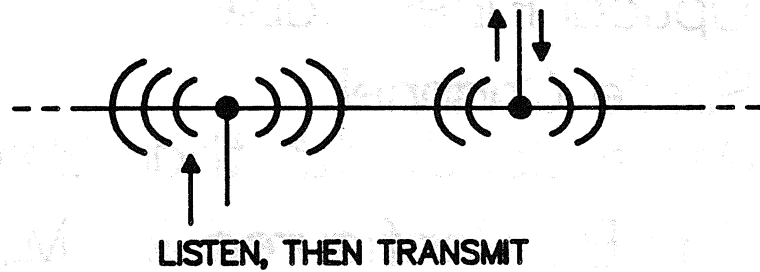
Token—Passing

- Distributed Control
- Deterministic Delay
- Synchronous Batch Mode Traffic
- Performance Maintained as Load Increases

1. RECEIVE TOKEN   2. SEND DATA, RECEIVE RESPONSE

3. PASS TOKEN
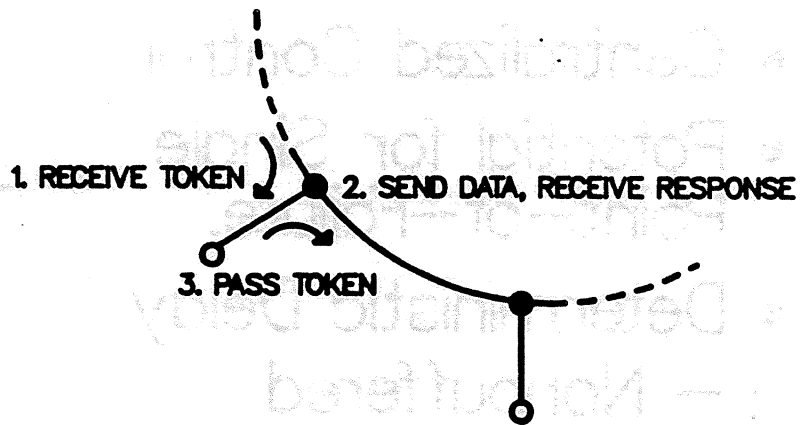
LAN Access Methods
Time Division Multiplexing (TDM)

- Centralized Control
- Potential for Single Point—of—Failure.
- Deterministic Delay
  - Nonbuffered
- Guaranteed Access to Medium
  - Nonblocked

TIME SLOTS
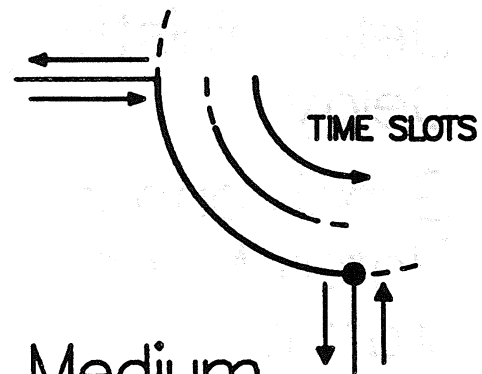
Access Method Selection Factors

	TDM	CSMA/CD	TOKEN PASSING
Distance Between Devices	/////	/////	/////
< 5 Miles	X	X	X
> 5 Miles	X	X	X
Type of Devices	/////	/////	/////
Intelligent			X
Nonintelligent		X	
Asynchronous		X	
Synchronous	X		X
Short, Bursty Messages		X	
Long, Bursty Messages		X	
Fixed Length, Bursty Messages	X	X	
Short, Regular Messages			X
Long, Regular Messages (File Transfers)			X
Fixed Lenght, Regular Messages	X		X

Communications Servers

- Router
  - Function of Supplying Virtual Circuits Between Different Networks.

- Gateway
  - Device that Interconnects Two Dissimilar Networks.

Communications Servers

- Repeater
  - Device that Makes Two (or More) Physical Segments Appear as One Logical Network.

- Bridge
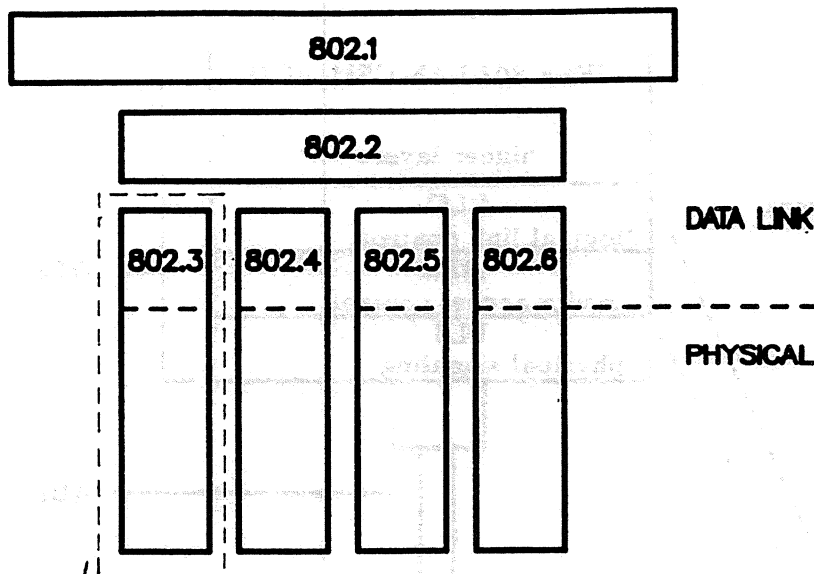 - Device that Interconnects Two Similar or Compatible Networks.

IEEE Project 802 Standards:

```
┌─────────────────────────────────────────┐
│                  802.1                    │
└─────────────────────────────────────────┘

    ┌───────────────────────────────────┐
    │               802.2                │
    └───────────────────────────────────┘

    ┌──────┐ ┌──────┐ ┌──────┐ ┌──────┐
    │      │ │      │ │      │ │      │        DATA LINK
    │802.3 │ │802.4 │ │802.5 │ │802.6 │    - - - - - - - - -
    │      │ │      │ │      │ │      │        PHYSICAL
    │      │ │      │ │      │ │      │
    └──────┘ └──────┘ └──────┘ └──────┘
```

IEEE Definition of Terms

802.1
— Document Describing Relation Between These
  Standards and Their Relation to OSI Model

802.2
— Logical Link Control Protocol Standard
  (HDLC Like) Used with Media Access Standards

(802.3)
— Media Access Standard Specified for Bus
  Topology and CSMA/CD Access Method
  (Ethernet)

802.4
— Media Access Standard Specifying Bus Topology
  and Token Passing Access Method

802.5
— Media Access Method Specifying Ring Topology
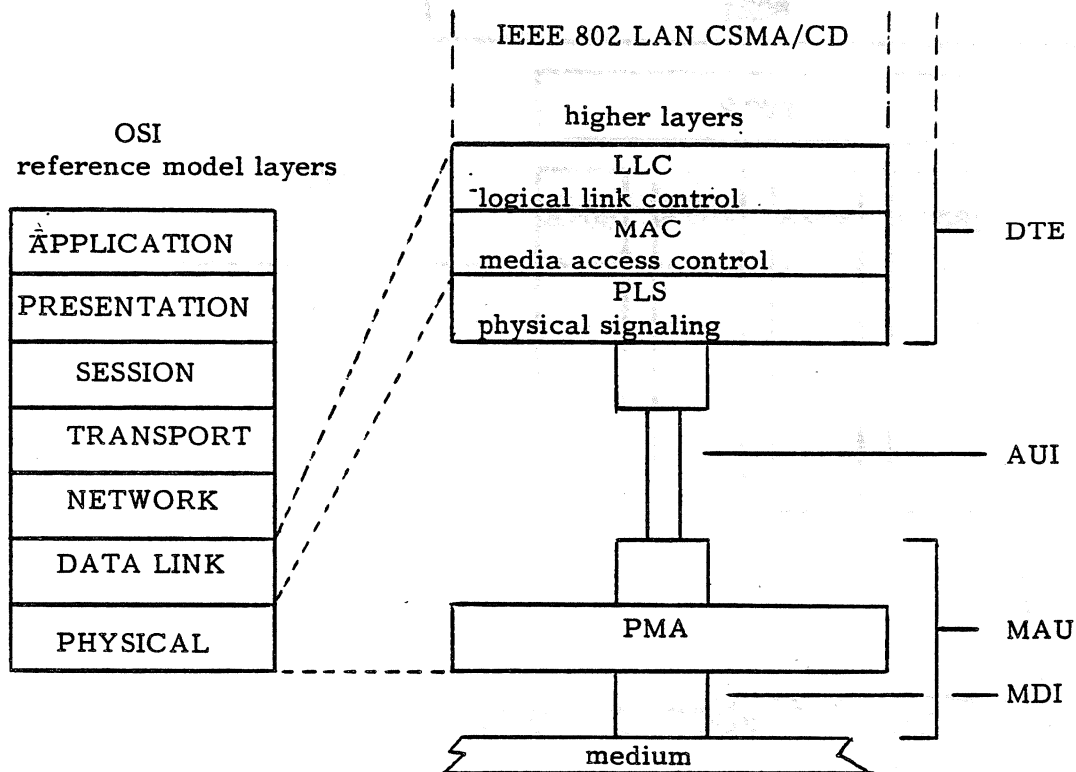 and Token Passing Access Method

802.6
— Media Access Method Specified for Metropolitan
  Area Network Using CATV Technology

OSI = Open System Interconnect
CSMA/CD = Carrier Sense Multiple Access with Collision Detect

LAN STANDARD RELATIONSHIP TO THE O.S.I.
REFERENCE MODEL

AUI - attachment unit interface

MAU - medium attachment unit

MDI - medium dependent interface

PMA - physical medium attachment

BASIC CONCEPTS

The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) media access method is the means by which to or more stations share a common bus transmission medium. To transmit, a station waits (defers) for a quiet period on the medium (that is no other station is transmitting) and then sends the intended message in bit serial form. If, after initiating a transmission, the message collides with that of another station, then each transmitting station intentionally sends a few additional bytes to ensure propagation of the collision throughout the system. The station remains silent for a random amount of time (backoff) before attempting to transmit again. Each aspect of this access method process is specified in detail in subsequent sections of this standard.

This is a comprehensive standard for Local Area Networks employing CSMA/CD as the access method. This standard is intended to encompass several media types and techniques for signal rates from 1Mb/s to 20Mb/s. This edition of the standard provides the necessary specification and related parameter values for a 10Mb/s baseband implementation.

INTRODUCTION

The Ethernet local area network provides a communication facility for high-speed data exchange among computers and other digital devices located within a moderate-sized geographic area. Its primary characteristics include:

Physical Layer:

Data rate: 10 Million bits/sec

Maximum station separation: 2.8 Kilometers

Maximum number of stations: 1024

Medium: Shielded coaxial cable, base band signalling

Topology: Branching non-rooted tree

Data Link Layer:

Link control procedure: Fully distributed peer protocol, with statistical contention resolution (CSMA/CD)

Message protocol: Variable size frames, "best-effort" delivery

STANDARD LAYERS OF O.S.I. (qpen system interconnect)
REFERENCE MODEL

system #1

7	APPLICATION
6	PRESENTATION
5	SESSION
4	TRANSPORT
3	NETWORK
2	DATA LINK
1	PHYSICAL

client layer

detail #1

system #2

7	APPLICATION
6	PRESENTATION
5	SESSION
4	TRANSPORT
3	NETWORK
2	DATA LINK
1	PHYSICAL

communication medium

For ETHERNET it will be a _____ .

DETAIL #1

Client Layer

Data Link Layer

Physical Layer

Data Link Controller   Physical Channel

FUNCTIONS

to station — Station Interface — Data Encapsulation — Link Mgmt — Encode & Decode — Transmit & Receive

detail #2

Ethernet Controller Board   Transceiver Cable   Transceiver   Coax Cable

TYPICAL IMPLEMENTATION

to I/O bus, etc.

Compatibility Interfaces

Ethernet Architecture and Typical Implementation

DETAIL #2

Client Layer

Data Link Interface

detail #2A

```
same
function
  as
 LLC
  &
 MAC
```

| Transmit Data Encapsulation | Receive Data Decapsulation |

detail #2B

| Transmit Link Management | Receive Link Management |

Physical Interface

Physical Layer

The data link layer defines a medium-independent link level communication facility, built on the medium-dependent physical channel provided by the physical layer. It is applicable to a general class of local area broadcast media suitable for use with the channel access discipline known as carrier-sense multiple-access with collision-detection (CSMA-CD). Compatibility with non-contention media (e.g., switched lines, token passing rings, etc.), while a worthwhile topic for further research, is not addressed in this manual.

The Data Link Layer specified here is intended to be as similar as possible to that described in the I.S.O. model. In a broadcast network like the Ethernet, the notion of a data link between two network entities does not correspond directly to a distinct physical connection. Nevertheless, the two main functions generally associated with a data link control proceedure are present:

Data encapsulation/decapsulation
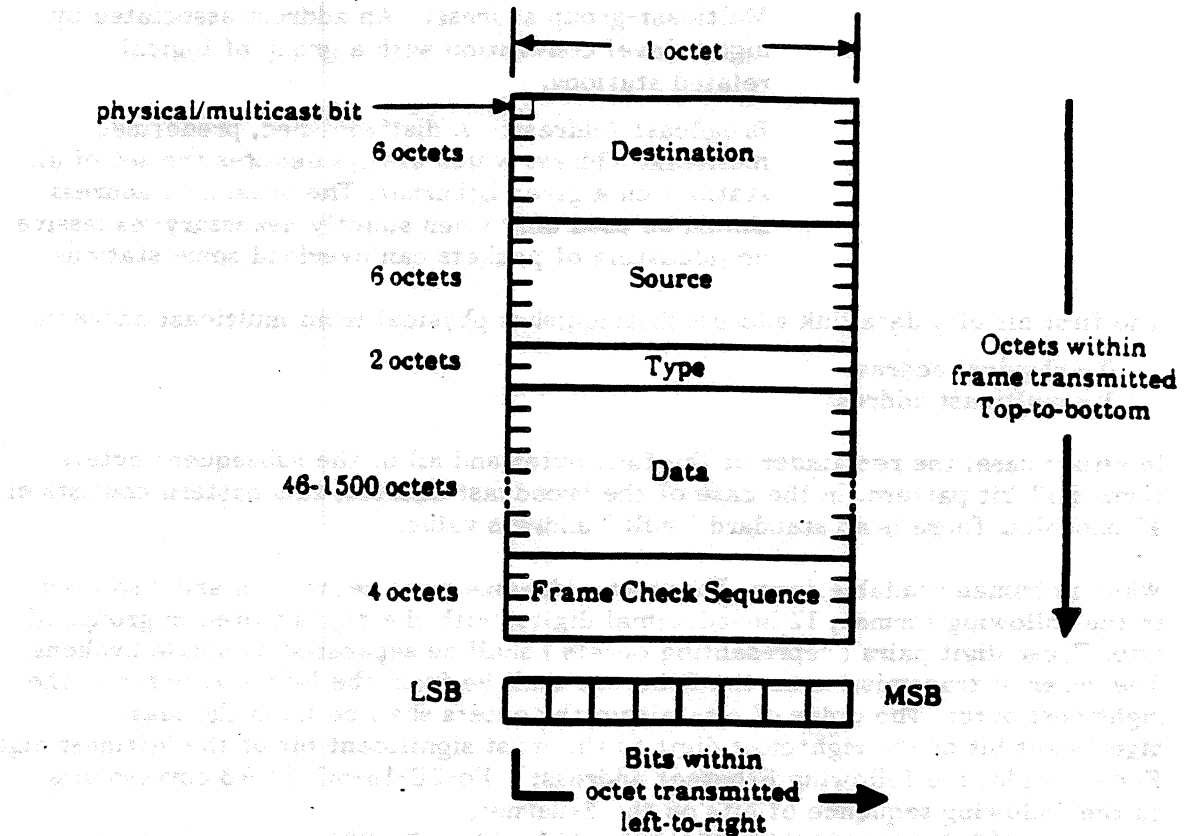   framing
        addressing
        error detection

Link Management
        channel allocation
        contention resolution

DATA LINK LAYER

(DETAIL #2A) ——————— DATA ENCAPSULATION
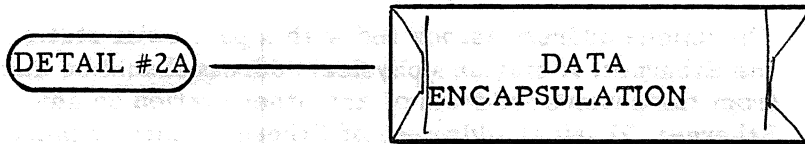
Frame Format

The data encapsulation function of the data link layer comprises the construction and processing of frames. The subfunctions of framing, addresing, and error detection are reflected in the frame format as follows:

1 octet

physical/multicast bit →

6 octets	Destination
6 octets	Source
2 octets	Type
46-1500 octets	Data
4 octets	Frame Check Sequence

Octets within frame transmitted Top-to-bottom

LSB ☐☐☐☐☐☐☐☐ MSB

Bits within octet transmitted left-to-right →

The octets of frame are transmitted from top to bottom, and the bits of each octet are transmitted from left to right.

The smallest valid frame contains 64 octets and the largest valid frame contains 1518 octets.

DATA LINK LAYER

Address Fields

Data link addresses are 6 octets (48 bits) in length. There are two types of data link addresses.

Physical Address: The unique address associated with a particular station on the Ethernet. A station's physical address should be distinct from the physical address of any other station on any Ethernet. Physical addresses of Ethernet stations must be displayed in human readable form, by either a tag or a label, an LED display, a properly documented software command, or some other well defined method.

Multicast Address: A multi-destination address, associated with one or more stations on a given Ethernet. There are two kinds of multicast addresses:

> Multicast-group address: An address associated by higher level convention with a group of logically related stations.

> Broadcast Address: A distinquished, predefined multicast address which always denotes the set of all stations on a given Ethernet. The broadcast address should be used only when strictly necessary; excessive broadcasting of packets can overload some stations.

The first bit of a data link address distinquishes physical from multicast addresses:

0 - physical address
1 - multicast address

In either case, the remainder of the first octet and all of the subsequent octets form a 47-bit pattern. In the case of the broadcast address, this pattern consists of 47 one-bits. There is no standard " null " address value.

When in human readable form, Ethernet addresses must be written and displayed in the following format; 12 hexadecimal digits, with the digits paired in groups of two. These digit pairs (representing octets) shall be separated by single hyphens. The order of transmission on the Ethernet shall be from the leftmost octet to the rightmost octet. The order of bits within the octets shall be from the least significant bit of the rightmost digit to the most significant bit of the leftmost digit. For example, the following Ethernet address;   Fo-2E-15-6C-77-9B corresponds to the following sequence of bits on the Ethernet;
    00001111011101001010100000011011011101110110111001   where the bits are transmitted from left to right.

DATA LINK LAYER

Destination Address Field

The destination address field specifies the station(s) for which the frame is intended. It may be a physical or multicast (including broadcast) address.

Source Address Field

The source address field contains the physical address of the station sending the frame. This field is not interpreted at the data link layer. It is specified at the data link level because a uniform convention for the placement of this field is crucial for most higher level protocols.

Client layers use the data link physical address for the source address of all frames transmitted.

Type Field

The type field consists of a two-octet value reserved for use by higher levels (in particular, to identify the client layer protocol associated with the frame). The type field is uninterpreted at the data link layer. It is specified at this level because a uniform convention for the placement and value assignment of this field is crucial if multiple higher level protocols are to be able to share the same Ethernet network without conflict.

Data Field

The data field contains a sequence of n octets, where 46 is less than n and n is less than 1500. Within this range, full data transparency is provided, in the sense that any arbitrary sequence of octet values may appear in the data field.

Frame Check Sequence Field

The frame check sequence (FCS) field contains a 4-octet (32-bit) cyclic redundancy check (CRC) value. This value is computed as a function of the contents of the source, destination, type and data fields (i.e., all fields except the frame check sequence field itself).

DATA LINK LAYER

```
(DETAIL #2B) ─────── ┌─────────────────────────┐
                     │        TRANSMIT         │
                     │     LINK MANAGEMENT      │
                     │                         │
                     └─────────────────────────┘
                                  │
                                  ▼
```
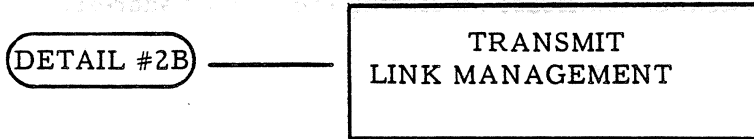
This includes carrier deference, interframe spacing, collision detection and
enforcement, and collision backoff and retransmission.

Carrier Deference

Even when it has nothing to transmit, the data link monitors the physical channel
for traffic by watching the carrier sense signal provided by the physical layer.
Whenever the channel is busy, the data link defers to the passing frame by delaying
any pending transmission of its own. After the bit of the passing frame, the data
link continues to defer for 9.6 microseconds minimum to provide proper interframe
spacing. At the end of that time, if it has a frame waiting to be transmitted,
transmission is initiated independent of the value of carrier sense. When transmission
has completed, the data link resumes its original monitoring of carrier sense. (if
there was nothing to transmit, the data link resumes its original monitoring of
carrier sense immediately.)

Interframe Spacing

The rules for defering to passing frames insure a minimum interframe spacing of
9.6 microseconds. This is intended to provide interframe recovery time for other
data link controlers and for the physical channel. Note that 9.6 microseconds is the
minimum value of the interframe spacing. If necessary for implementation reasons,
a transmitting controler may use a larger value with a resulting decrease in its
maximum throughput. The value shoul not exceed 10.6 microseconds.

Collision Handling

Once the data link has finished deferring and has started taransmission, it is still
possible for it to experience contention for the channel. Collisions can occur until
acquisition of the network has been accomplished through the deference of all
other data link controlers. The dynamics of collision handling are largely determined
by a single parameter called the slot time. This single parameter describes three
important aspects of collision handling:

> It is an upper bound on the acquisition time of the network.
> It is an upper bound on the length of a frame fragment generated by
> a collision.
> It is the scheduling quantum for retransmission.

In order to fulfill all three functions, the slot time must be larger than the sum of
the physical layer round-trip propagation time (less than 464 bit times) and the
data link layer maximum jam time (48 bit times) the slot time is defined to be
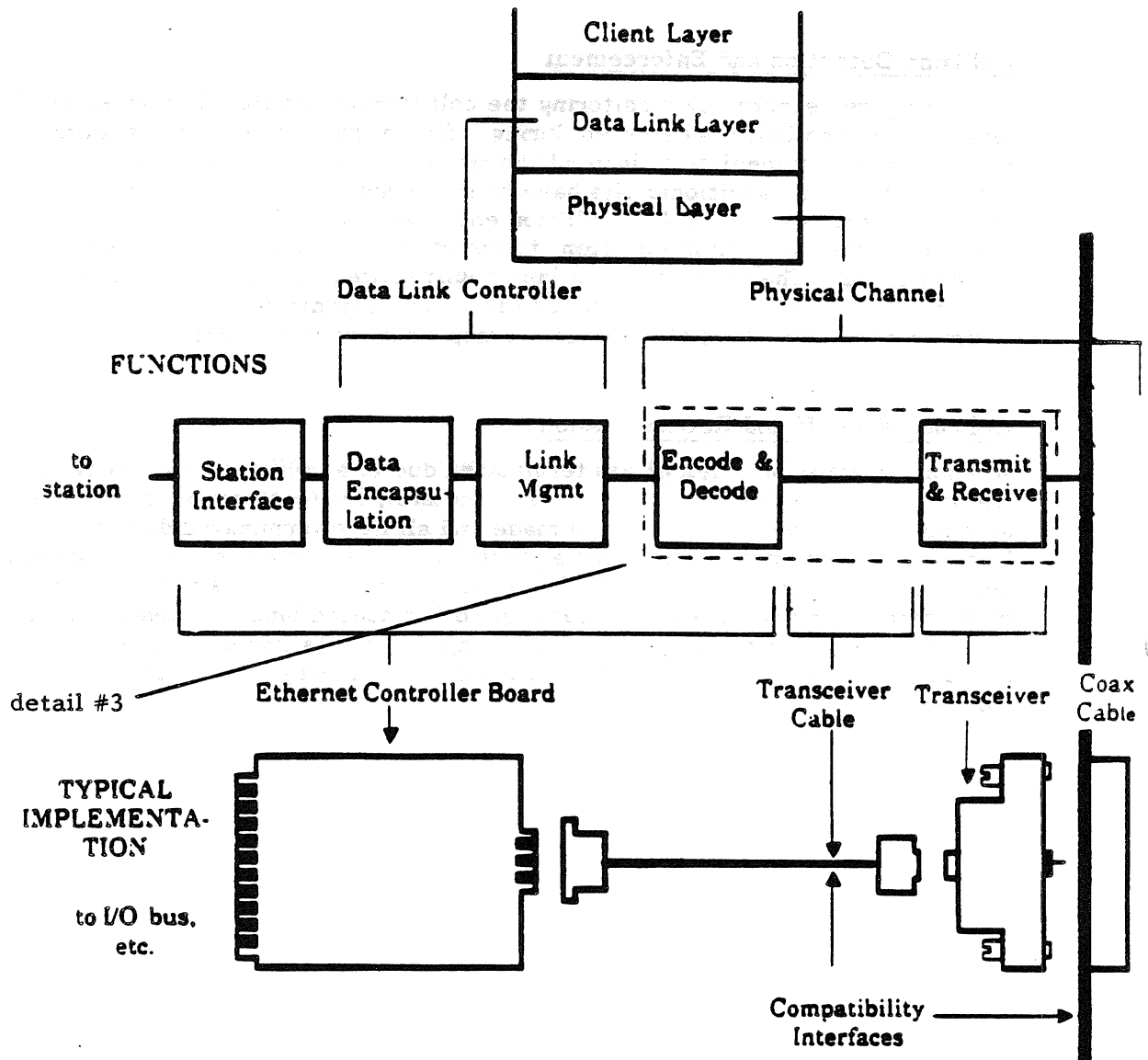512 bit times.

TRANSMIT LINK MANAGEMENT (continued)

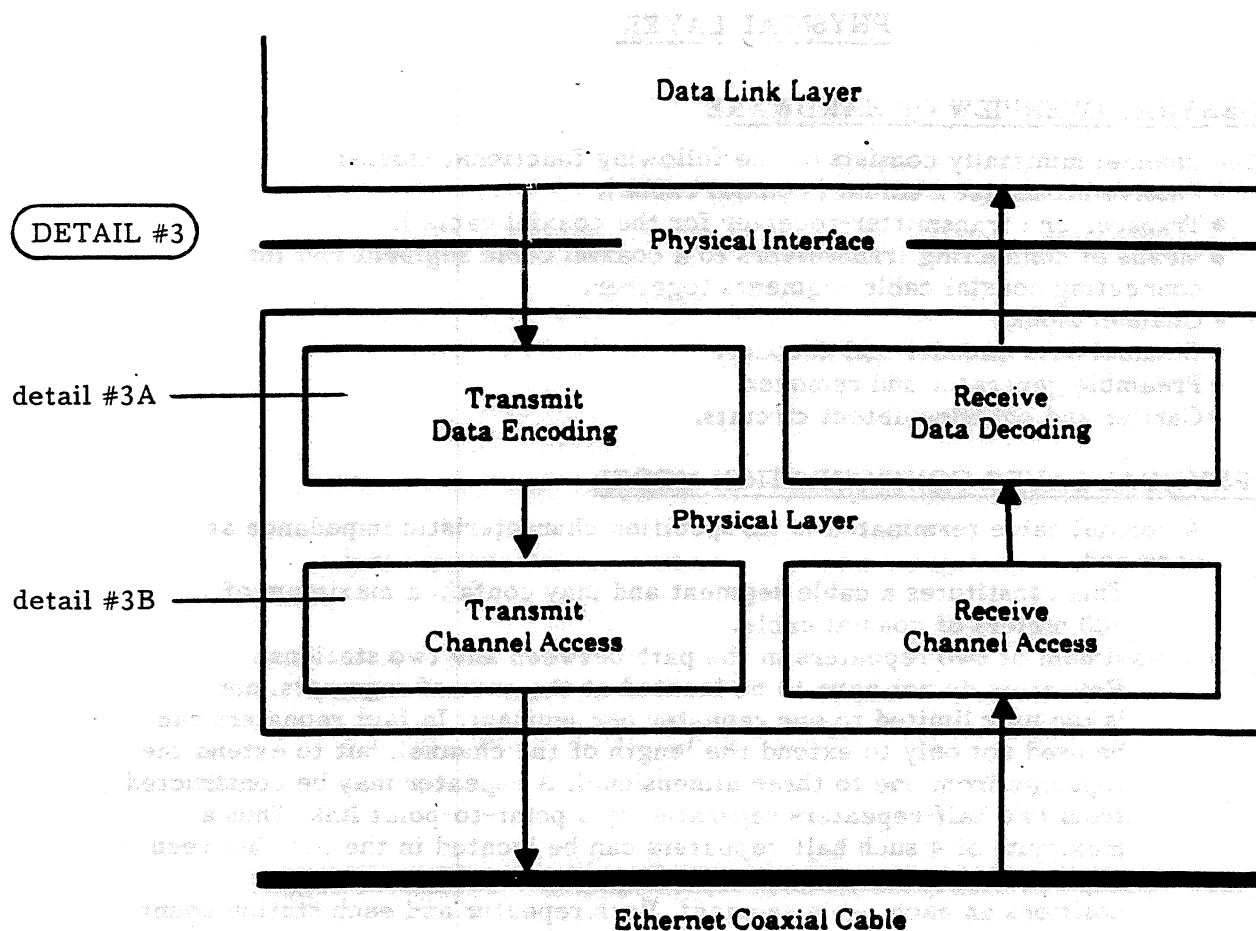### Collision Detection and Enforcement

Collisions are detected by monitoring the collision detect signal provided by the physical
layer. When a collision is detected during a frame transmission, the transmission is
not terminated immediately. Instead the transmission continues until at least 32 (but
not more than 48) additional bits have been transmitted (counting from the time
collision detect went on). This collision enforcement or "jam" guarantees that the
duration of the collision is sufficient to insure its detection by all transmitting stations
on the network. The content of the jam is unspecified; it may be any fixed or variable
pattern convenient to the data link controler implementation, but should not be
designed to be the 32-bit CRC value corresponding to the (partial) frame transmitted
prior to the jam.

Collision Backoff and Retransmission

When a transmission attempt has terminated due to a collision, it is retried by the
transmitting data link until either it is successful, or 16 attempts (the original
attempt plus 15 retries) have been made and all have terminated due to collisions.
Note that all attempts to transmit a given frame are completed before any subsequent
outgoing frames are transmitted. The scheduling of the retransmissions is determined
by a controled randomization process called "truncated binary exponential backoff."
At the end of enforcing a collision (jamming), the data link delays before
attempting to retransmit the frame. The delay is an integral multiple of the
slot time.

Client Layer

Data Link Layer

Physical Layer

Data Link Controller   Physical Channel

FUNCTIONS

to
station
Station
Interface

Data
Encapsu-
lation

Link
Mgmt

Encode &
Decode

Transmit
& Receive

detail #3

Ethernet Controller Board

Transceiver
Cable

Transceiver

Coax
Cable

TYPICAL
IMPLEMENTA-
TION

to I/O bus,
etc.

Compatibility
Interfaces

Ethernet Architecture and Typical Implementation

Data Link Layer

Physical Interface

detail #3A

**Transmit
Data Encoding**

**Receive
Data Decoding**

Physical Layer

detail #3B

**Transmit
Channel Access**

**Receive
Channel Access**

Ethernet Coaxial Cable

CHARACTERISTICS OF THE PHYSICAL LAYER

- The ability to send and receive information (non-simultaneously) between any two or more data link entities on the same network.
- The ability to detect the presence of another station's transmission while not transmitting (carrier sense).
- The ability to detect the presence of another station's transmission while transmitting (collision detect).
- A total worst-case round trip signal propagation delay (including actual propagation time, synchronization time for all intervening electronics, and signal rise time degradation) of less than 464 bit times (equal to 46.4 microseconds for this 10Mbps channel).

FUNCTIONS PROVIDED BY THE PHYSICAL LAYER

- Means for transmitting and receiving serial bit streams between the data link layer and the media.
- Generation of clock for synchronization and timing.
- Means for detecting carrier (non-idle channel).
- Means for detecting collisions (simultaneous transmission attempts by multiple stations).
- Coding and decoding of the data link bit stream into a self synchronizable sequence of electrical signals suitable for transmission on the media provided by the channel.
- Generation and removal of coding-specific preamble information (a synchronizing header sequence inserted before the first bit of the frame) to ensure that all channel electronics are brought to a known steady state before the data link frame is transmitted.

PHYSICAL LAYER

GENERAL OVERVIEW OF HARDWARE

The channel minimally consists of the following functional blocks:
- Passive broadcast medium (coaxial cable).
- Transceiver (transmitter-receiver for the coaxial cable).
- Means of connecting transceivers to a coaxial cable segment and for connecting coaxial cable segments together.
- Channel clock.
- Channel data encoder and decoder.
- Preamble generator and remover.
- Carrier and collision detect circuits.

PHYSICAL LAYER CONFIGURATION MODEL

A coaxial cable terminated in its specified characteristic impedance at each end.

> This constitutes a cable segment and may contain a maximum of 500 meters of coaxial cable.

- A maximum of two repeaters in the path between any two stations.

> Repeaters do not have to be located at the ends of segments, nor is the user limited to one repeater per segment. In fact repeaters can be used not only to extend the length of the channel, but to extend the topology from one to three dimensional. A repeater may be constructed from two half-repeaters separated by a point-to-point link. Thus a maximum of 4 such half-repeaters can be located in the path between any two stations in the network. Repeaters occupy transceiver positions on each cable segment. Each repeater and each station count towards the maximum number of transceivers on a segment.

- A maximum multidrop (Ethernet) coaxial cable length along the longest path between any two transceivers of 1500 meters.
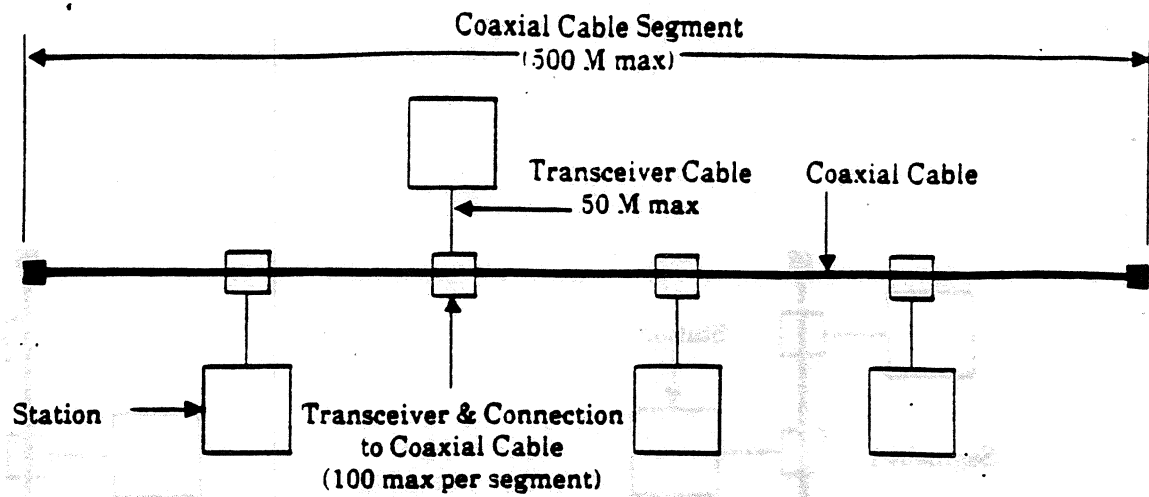
> The propagation velocity of the coaxial cable is assumed to be 0.77c worst-case. (c is the velocity of light in a vacuum; 300,000 kilometers per second). The total round trip delay for all the multidrop (Ethernet) coaxial cable in the system is therefore 13 microseconds worst-case.

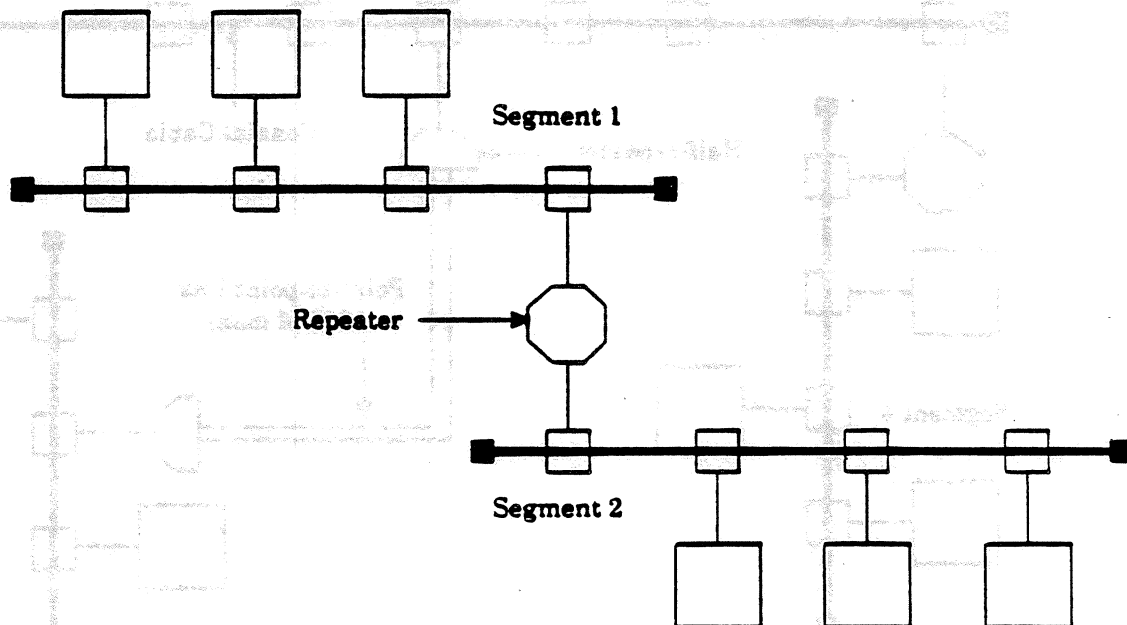- A maximum of 50 meters of transceiver cable between any station and its associated transceiver.

> Note that in the worst-case the signal must pass through six 50 meter transceiver cables, one at the transmitting station, one at the receiving station, and two at the repeater (two repeaters possible). The propagation velocity of the transceiver cable is assumed to be .65c worst-case. The total round trip delay for all the transceiver cables is therefore 3.08 microseconds worst-case.

- A maximum aggregate of 1000 meters of point-to-point links between any two stations in the system.

> These point-to-point links are normally intergrated within repeaters, and can be used to connect cable segments in different buildings. However, this does not mean that there can only be one point-to-point link in the system. There can be as many point-to-point links as repeaters (though not all can be 1000 meters). The worst-case propagation velocity of the point-to-point link cable is assumed to be .65c; the round-trip propagation delay for 1000 meters is 10.26 microseconds.

Coaxial Cable Segment
(500 M max)

Transceiver Cable
50 M max

Coaxial Cable

Station

Transceiver & Connection
to Coaxial Cable
(100 max per segment)

Minimal Configuration

Segment 1

Repeater

Segment 2

A Typical Medium-scale Configuration

Station

Segment 1

Segment 2

Repeater

Segment 3

Coaxial Cable

Half-repeater

Point-to-point link
(1000 M max)

Segment 4

Segment 5
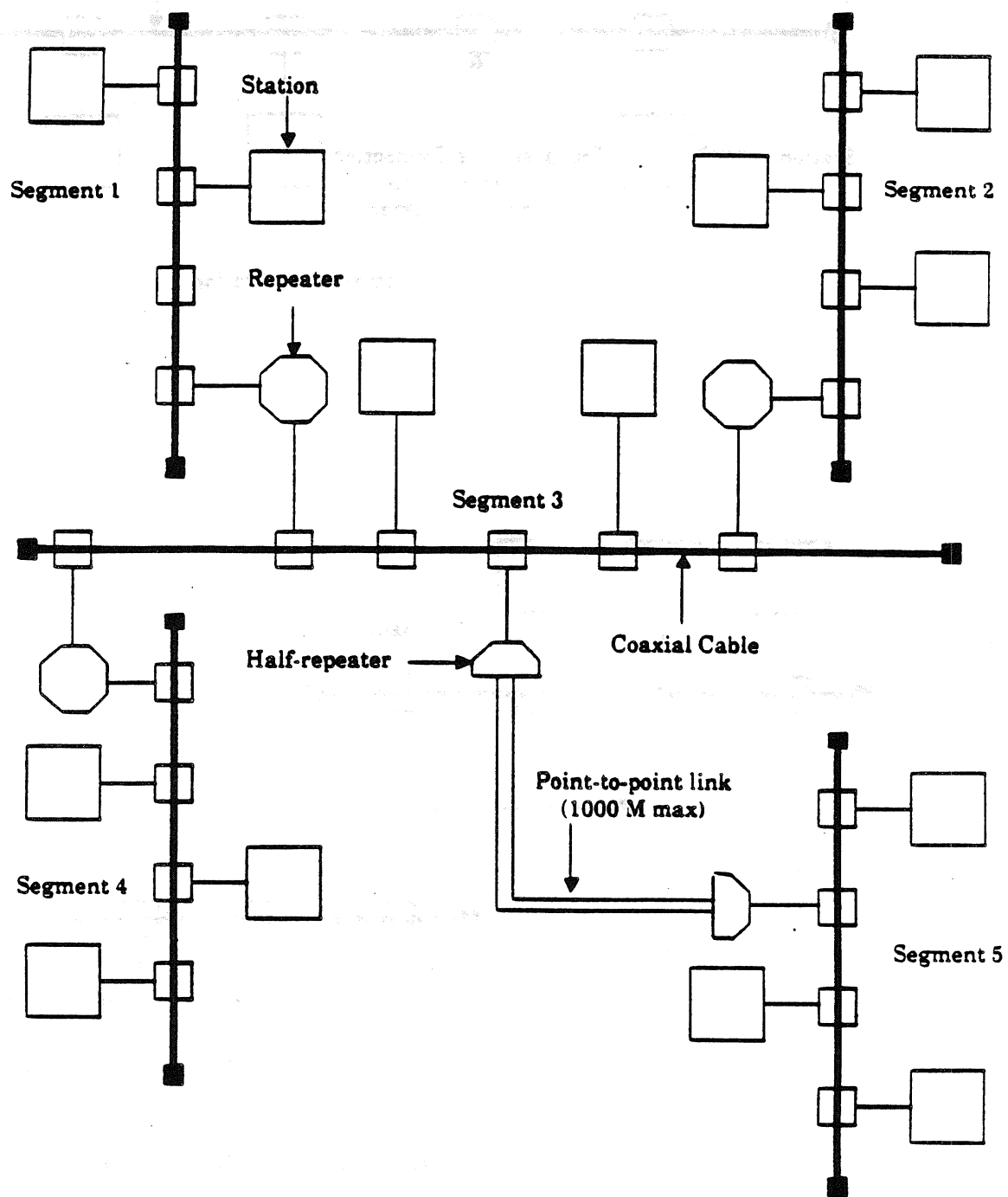
A Typical Large-scale Configuration

```
                    ┌─────────────────────────┐
                    │  ENCODING               │
 ⟨DETAIL #3A⟩───────┤        &                │
                    │          DECODING       │
                    └─────────────────────────┘
```

ENCODER

The encoder is used to translate physically separate signals of clock (synchronization) and data into a single synchronizable serial bit stream, suitable for transmission on the coaxial cable by the transceiver. During the first half of the bit cell time, the serial signal transmitted is the logical complement of the bit value being encoded during that cell. During the second half of the bit cell time, the uncomplemented value of the bit being encoded is transmitted. Therefore, there is always a signal transition (either positive-going or negative-going, depending on the bit encoder) in the center of each bit cell. The encoder outout drives the transmit pair of the transceiver cable, and ultimately, the coaxial cable through the transceiver. The encoder output timing distortion must not exceed 0.5ns. The encoder shall provide the defined output for the first (and all subsequent) bits presented to its input. All information submitted for encoding shall appear at the ouput of the encoder.
The steady-state propagation delay of the encoder shall not exceed 100ns. The delay between the presentation of valid clock and data to the encoder and the presentation of the encoded signal to the transmit pair shall not exceed 100ns.

DECODER

The decoder is used to separate the incoming phase encoded bit stream into a data stream and clock signal. The decoder must be able to provide data and clock signals usable by the data link under the timing distortion imposed by the worst-case system configuration. The decoder must provide usable output (clock and data) after no more than 16 bit cell times following reception an encoded signal (the assertion of carrier sense). The first signals received from the transceiver at the beginning of frame reception may not constitute a valid, properly encoded bit; it is possible for the time from the first transition seen to the first true mid-bit cell transition to assume any value from zero to 100ns.
The decoder input is normally derived from the coaxial cable, through the transceiver cable receive pair. It is not necessary for the decoder to provide usable output when there is a collision on the coaxial cable, regardless of whether the station using that decoder is involved in the collision.

PREAMBLE GENERATION

Because most of the channel circuitry is allowed to provide valid output some number of bit times after being presented valid input, it is necessary for a preamble to be sent before the start of data link information, to allow the channel circuitry to reach its steady state, with valid outputs through out the system. Upon request of the data link to transmit the first bit of a new frame, the channel shall first transmit the preamble, a predetermined bit sequence used for channel stablization and synchronization. If, while transmitting the preamble, the channel logic asserts the collision detect signal, any remaining preamble bits must be sent before proceeding with the transmission of the bit submitted by the data link.
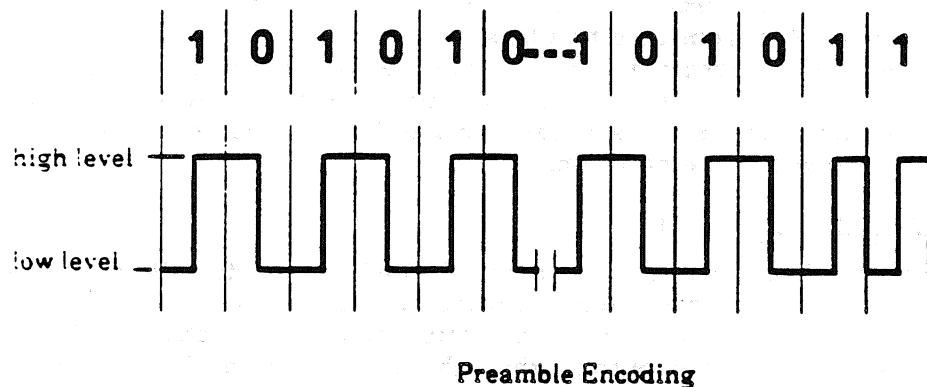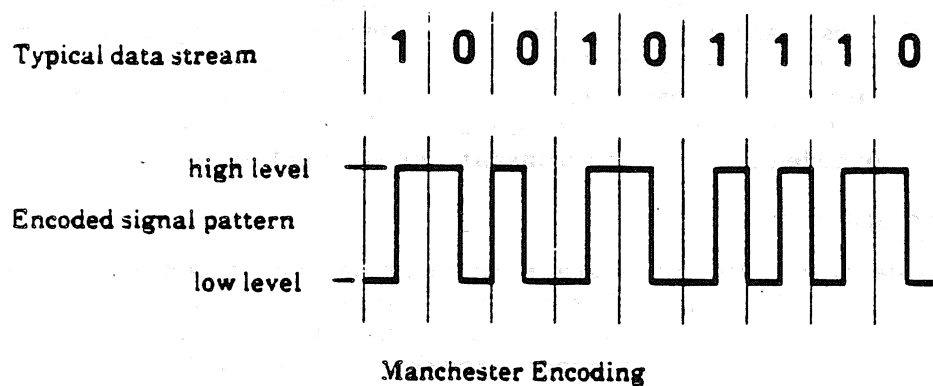
PHYSICAL LAYER

PREAMBLE GENERATION (continue)

The preamble is a 64 bit pattern to be presented to the channel encoder in the same manner as data link information. This pattern is;

1010101010101010101010101010 ----------------------1010101010101010101011.

The bit s are transmitted in order, from left to right. The nature of the pattern is such that when encoded, it appears as a periodic waveform on the cable, with a 5MHZ frequency. Excepting the final two bits, the only transitions present in the waveform are in the center of the bit cells. The last two bits of the preamble contain transitions at both the bit cell centers and the edges, and are used to indicate the end of the preamble and the beginning of the data link encapsulation portion of the frame. The next bit transmitted is the bit originally submitted for transmission by the data link.

Typical data stream: | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |

Encoded signal pattern (high level / low level)

Manchester Encoding

| 1 | 0 | 1 | 0 | 1 | 0---1 | 0 | 1 | 0 | 1 | 1 |

high level / low level

Preamble Encoding

```
                    ┌─────────────────────────┐
 (DETAIL #3B) ──────┤      CHANNEL ACCESS     │
                    └─────────────────────────┘
                                  │
```

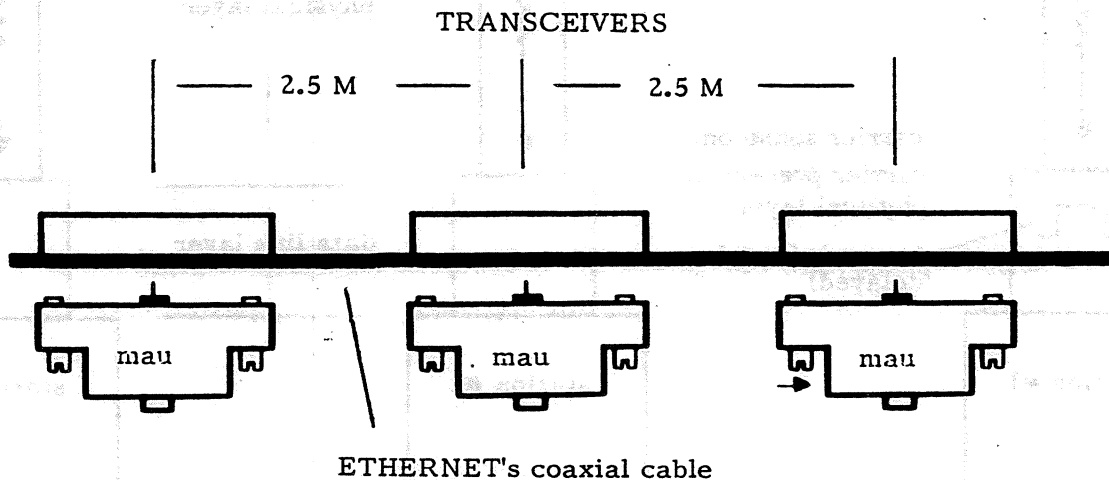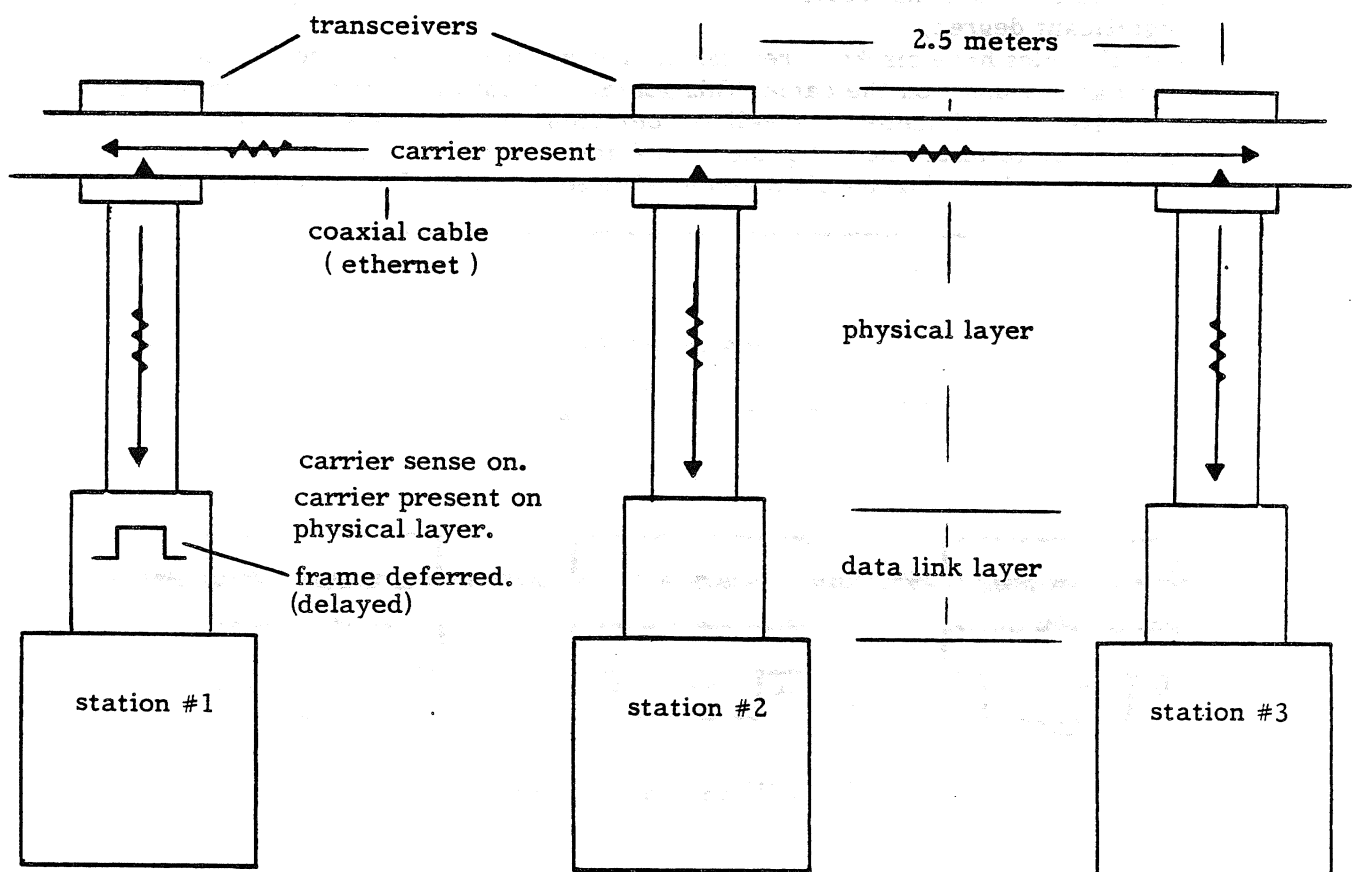## TRANSCEIVER PLACEMENT

Transceivers and their associated connections to the cable cause signal reflections
due to their non-infinite bridging impedance. While this impedance must be
implemented, the placement of transceivers along the coaxial cable must be
controled to insure that reflections from transceivers do not add in phase to
a significant degree.
Coaxial cables have marks at regular 2.5 meters spacing; a transceiver may be
placed at any mark on the cable. This guarantees both minimum spacing between
transceivers at 2.5 meters, as well as controling the relative spacing of
transceivers to insure non-alignment on fractional wavelength boundaries.
The total number of transceivers on a cable segment shall not exceed 100.

TRANSCEIVERS

| ── 2.5 M ── | ── 2.5 M ── |

ETHERNET's coaxial cable

TRANSMITTING WITHOUT CONTENTION

transceivers

2.5 meters

carrier present

coaxial cable
(ethernet)

physical layer

carrier sense on.
carrier present on
physical layer.

frame deferred.
(delayed)

data link layer

station #1

station #2

station #3

TRANSMITTING WITHOUT CONTENTION

transceivers

2.5 meters

coaxial cable
(ethernet)

physical layer

carrier is not present.

carrier sense off.

interframe spacing
initiated for at least
9.6 microseconds, to
allow recovery time
for data link cont -
rolers and the
physical channel.

data link layer

station #1

station #2

. station #3

TRANSMITTING WITHOUT CONTENTION

transceivers

2.5 meters

carrier present

coaxial cable
(ethernet)

frame transmitted producing
carrier on the physical
layer.

preamble attached to the
frame for stablization and
synchronization (clocking)
of the physical channel.

physical layer

data link layer

station #1

station #2

station #3

COLLISIONS

transceivers

2.5 meters

collision (stations 1 & 2)

coaxial cable
(ethernet)

both stations transmitting
simultaneously.

collision detect signal comes
on, both stations.

the "jam" is initiated.
(collision enforcement)

retransmission begins after
"backoff" time expires.

maximum of 15
retries.

physical layer

data link layer

station #1

station #2

station #3

PHYSICAL LAYER

AUI — ATTACHMENT UNIT INTERFACE
DTE — DATA TERMINAL EQUIPMENT
MAU — MEDIA ACCESS UNIT

Typical Ethernet/IEEE 802.3 Node

PREAMBLE 1010 ... 1010	SYNC 1 1	DEST. ADR	SOURCE ADR	TYPE	DATA	FCS
62 BITS	2 BITS	6 BYTES	6 BYTES	2 BYTES	46–1500 BYTES	4 BYTES

Ethernet Frame Format

PREAMBLE 1010 ... 1010	SFD 10101011	DEST. ADR	SOURCE ADR	LENGTH	LLC DATA	PAD	FCS
56 BITS	8 BITS	6 BYTES	6 BYTES	2 BYTES	46–1500 BYTES		4 BYTES
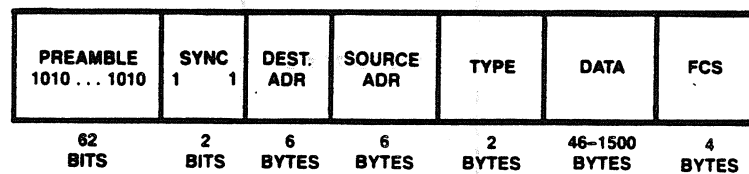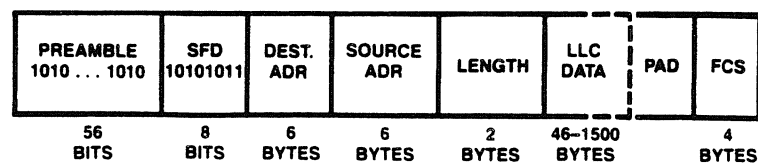
IEEE 802.3 MAC Frame Format

PHYSICAL LAYER

DATA LINK LAYER

Ethernet coax

transceiver

MAU

AUI cable

DTE

encode and decode

decode

PREAMBLE 1010...1010 62 BITS	SYNC 11 2 BITS	DEST ADR 6 BYTES	SOURCE ADR 6 BYTES	TYPE 2 BYTES	DATA 46-1500 BYTES	FCS 4 BYTES

AM7991 SIA

link management

DEST ADR 6 BYTES	SOURCE ADR 6 BYTES	TYPE 2 BYTES	DATA 46-1500 BYTES	FCS 4 BYTES

the ETHERNET CSMA/CD network access algor-ithm is implemented completely within the LANCE.

AM7990 LANCE

data encapsulation

decapsulation

DEST ADR 6 BYTES	SOURCE ADR 6 BYTES	TYPE 2 BYTES	DATA 46-1500 BYTES	FCS 4 BYTES

ETHERNET

local memory

local cpu

local bus

BASIC SYSTEM OPERATION

Ethernet is a send and receive, half-duplex system. The node functions in either transmit or receive mode at any instant in time. Before transmission the node must be shure there is no contention for the bus. Each node monitors the coax and will defer its transmission sequence if the coax is in use. In addition to listening for a clear coax before transmitting, Ethernet handles collision in a predetermined way. Should two nodes attempt to transmit at the same time, the signals will collide and the data on the coax will be garbled. The transmitting nodes listen while they transmit. If they detect a collision, they continue to transmit for an additional 80ns to be shure the collision is recognized by all nodes in the network. The transmitting nodes then delay a random amount of time according to the " truncated binary backoff " algorithm implemented in the LANCE, before attempting to transmit again. This minimizes the probability of collision on retransmission.
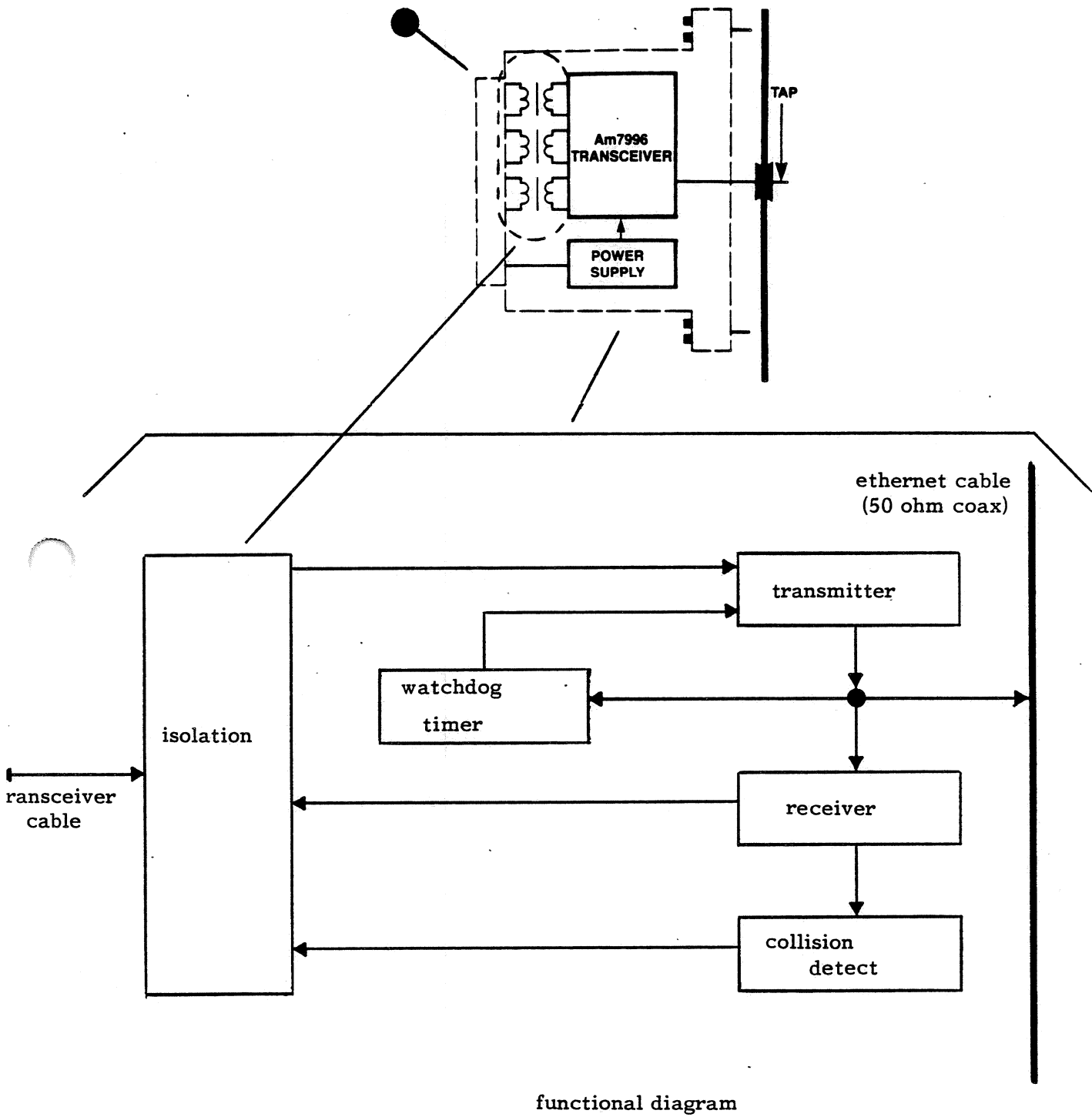
TRANSMIT MODE

In the transmit mode, the LANCE initiates a DMA cycle to access data from the transmit buffer area of a node's local memory. It prefaces the data with a preamble and sync pattern and then calculates and appends a 32 bit CRC check word. The resulting packet is passed serially to the SIA. The manchester encoder in the SIA creates the encoded differential signals TRANSMIT + and TRANSMIT - to drive the transceiver cable. These differential signals are coupled through the transceiver cable to the transceiver and on the Ethernet coaxial cable.
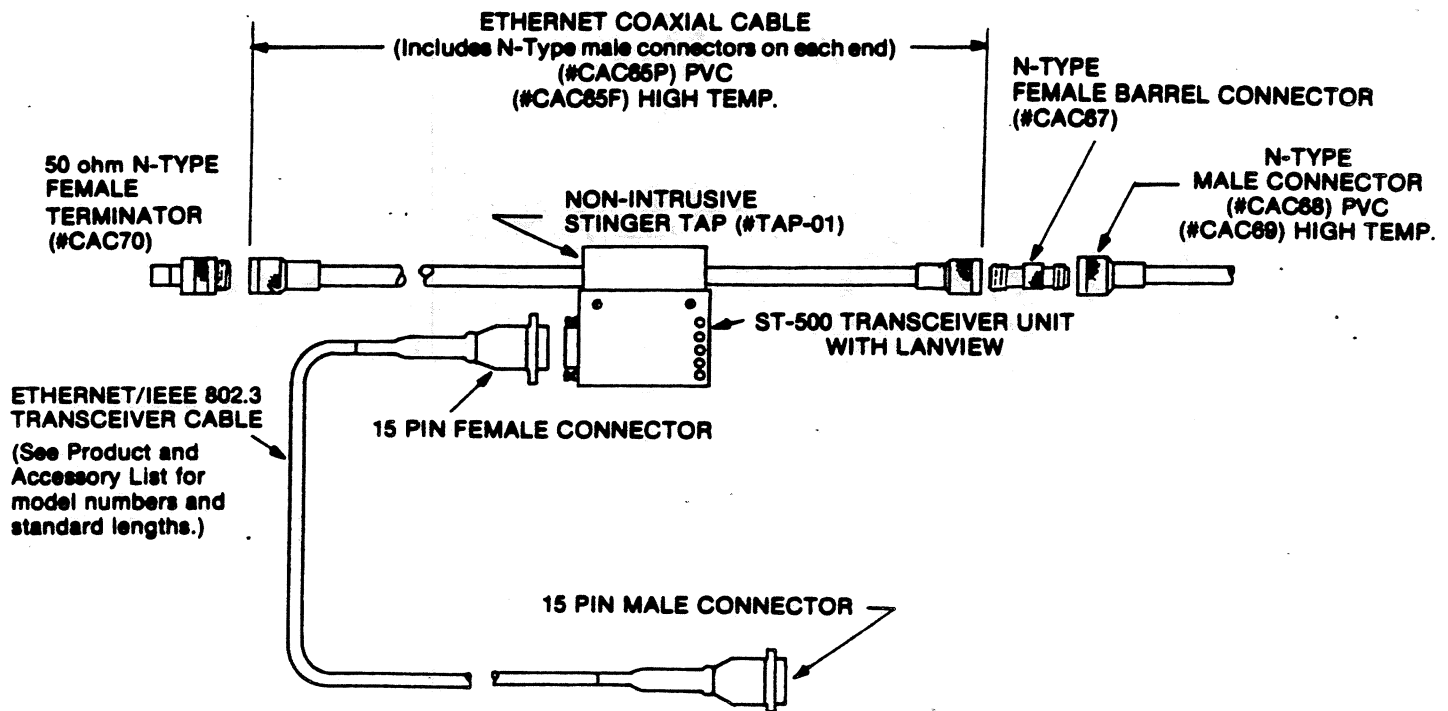
RECEIVE MODE

When carrier is present on the Ethernet coax, the transceiver will create the differential signals RECEIVE + and RECEIVE -. These inputs to the SIA are decoded by the manchester decoder. The SIA's phase locked loop synchronizes to the Ethernet Preamble, allowing the decoder to recover clock and data from the encoded signals. These two signals are supplied to the LANCE as the TTL signals RECEIVE DATA and RECEIVE CLOCK. In addition, the SIA creates the signal RECEIVE ENABLE (RENA) while it is receiving data from the cable, indicating to the LANCE that incoming data and clock are available. When data reaches the LANCE, the CRC check word is recalculated and compared to the CRC checksum at the end of the packet. If the CRC's do not agree, an error bit is set and an interupt request is generated to the local processor.
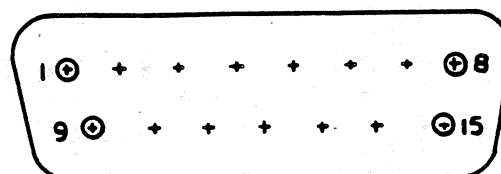
PHYSICAL LAYER

Am7996 TRANSCEIVER

TAP

POWER SUPPLY

ethernet cable
(50 ohm coax)

transmitter

watchdog timer

isolation

ransceiver cable

receiver

collision detect

functional diagram

ETHERNET COAXIAL CABLE
(Includes N-Type male connectors on each end)
(#CAC65P) PVC
(#CAC65F) HIGH TEMP.

N-TYPE
FEMALE BARREL CONNECTOR
(#CAC67)

50 ohm N-TYPE
FEMALE
TERMINATOR
(#CAC70)

N-TYPE
MALE CONNECTOR
(#CAC68) PVC
(#CAC69) HIGH TEMP.

NON-INTRUSIVE
STINGER TAP (#TAP-01)

ST-500 TRANSCEIVER UNIT
WITH LANVIEW

ETHERNET/IEEE 802.3
TRANSCEIVER CABLE

(See Product and
Accessory List for
model numbers and
standard lengths.)

15 PIN FEMALE CONNECTOR

15 PIN MALE CONNECTOR

INTERFACE

Figure shows the ST-500 physical interface to the transceiver cable.

LEGEND

Pin 1 Logic Ref
    2 Collision +
    3 Transmit +
    4 Logic Ref
    5 Receive +
    6 Power Return
    7 N/C
    8 Logic Ref

Pin 9 Collision-
    10 Transmit -
    11 Logic Ref
    12 Receive -
    13 Power
    14 Logic Ref
    15 N/C

Shell: Cable Shield and ST-500 Case.

15-Pin Male D-connector on the ST-500

Ethernet Coaxial Cable

Pressure Screw

Clamp Section

Cable Bed Section

Braid Picks

Center Probe

Flat-Head Screws

UNPACKING THE ST-500

The package contains:

    1 ST-500 Transceiver
    2 Flat head screws for attaching tap to transceiver.
    1 Tap kit (see section on installation)
    1 User Manual

IMPORTANT: Always inspect the ST-500 for damage which may have occurred during shipment. If the unit is damaged, please call Cabletron's Customer Service. For convenience be sure to save the shipping carton for reshipment.

HOW TO INSTALL

This section explains how to install the three styles of taps offered by Cabletron.

It is important to realize that any one of the three taps may be installed and capped for future use. Installation of these taps prior to use allows all taps to be tested at one time. The taps offered by Cabletron are also compatible with many other types of transceivers on the market today. Cabletron can provide both the taps and transceivers separately, such that one time installation of taps is easily accomplished.

Cabletron Model ST-500-0

    Tapless Transceiver

Cabletron Model ST-500-1

    Transceiver with non-intrusive stinger style tap

Cabletron Model ST-500-2

    Transceiver with intrusive N-Series tap

Cabletron Model ST-500-3

    Transceiver with BNC style tap, compatible with DEC DESTA and compact transceivers for use on PC networks and DEC Connect.

If extra taps are required, the type of tap need only be called out (Tap-01, Tap-02, Tap-03).

To install a Cabletron ST-500-1 Transceiver onto an active Ethernet/IEEE 802.3, you need the following:

    An Ethernet coaxial cable

    A Cabletron ST-500 Ethernet transceiver with non-intrusive stinger style tap.

   A Cabletron IK-500 Installation Kit

    Small flat screw driver
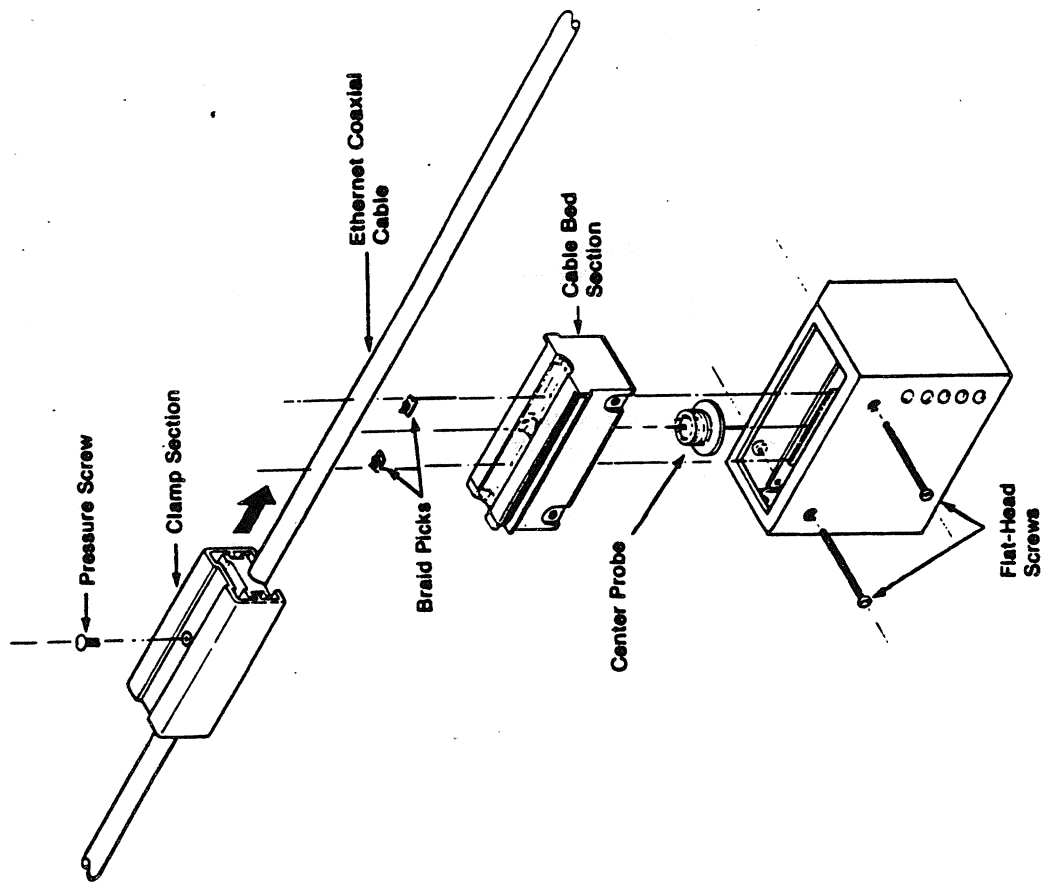
1) Remove the cable bed piece and braid picks from the Blister-pack tap kit.

2) Insert the braid picks into the holes in the cable bed section so that the long dimension of the braid pick is parallel to the cable direction.

3) Determine tapping location on the coaxial cable.

4) Locate cable firmly down into the cable bed section.

5) Slide the clamp section along the cable and into the guide slots in the cable bed section.

Pressure Screw

Clamp Section

Ethernet Coaxial Cable

Braid Picks

Cable Bed Section
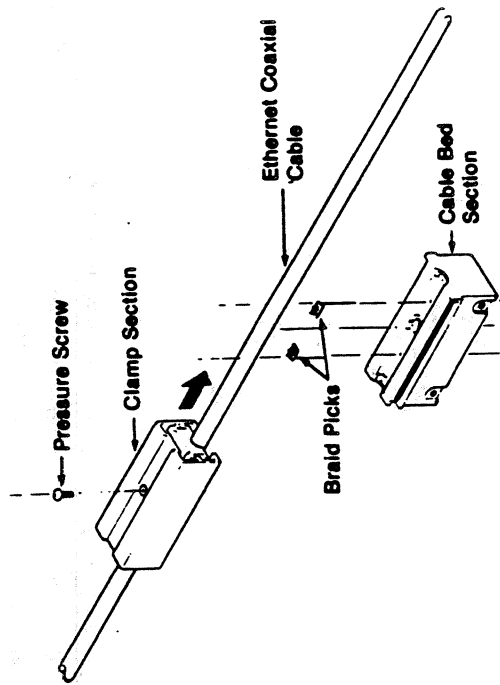
6) Using the allen wrench supplied in the IK-TAP-01 installation kit, screw in the pressure screw and tighten until it is snug.

7) Insert the hand coring tool into the center hole.

8) Twist the hand drilling tool clockwise, and drill a hole into the cable. (The coring tool has a stop to prevent overdrilling).

When coring tool turns freely, remove the coring tool and examine the hole.

The hole should be free of debris. It should go through the outer jacket, through the braid shield, and into the white dialectric. The hole is intended to allow the center probe to make contact with the cables center conductor just below the white dialectric.
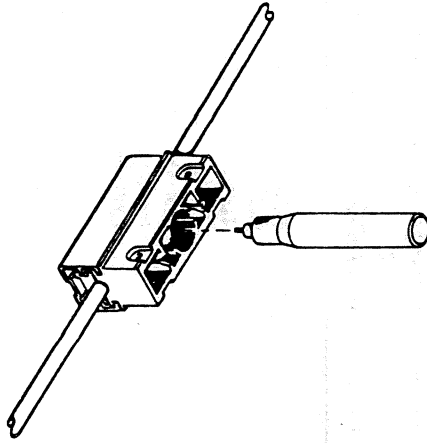

9) Using the opposite end of the coring tool, place the center probe into the central hole and tighten until it is snug.
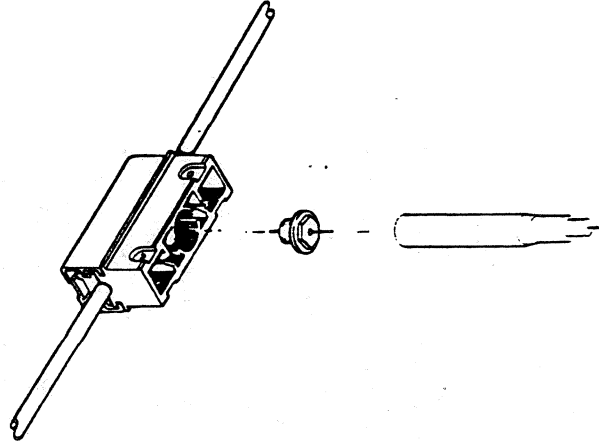
You are now ready to attach the transceiver body to the tap.

10) Remove the flat head screw from the ST-500 case and position the tap so that the rectangular hole in the case is aligned with the tap.

11) Slide the tap into the ST-500 case, make sure the pins in the tap line up with the connector on the enclosed circuit board.

   NOTE: Do not force the tap into the case, very little force is necessary.
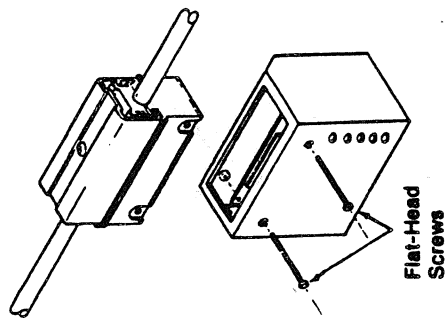
Flat-Head
Screws

12) Insert and tighten the flat head screws as shown in the above figure.

13) Test the transceiver and transceiver tap using a CABLETRON LAN-MD.

You are now finished connecting the ST-500-1 transceiver to the Ethernet Coaxial Cable.

CONNECTION OF THE ST-500 TO HOST

After the cable tap has been applied and the transceiver connected to the tap, the transceiver must then be connected to the Host System.

The connection of the ST-500 to a host requires the use of a transceiver cable.

IMPORTANT: A critical item on the efficient throughput of a network is the proper matching of transceiver cable to host Ethernet or IEEE802.3 controller. Since Ethernet Version 1.0, Version 2.0 and IEEE 802.3 standards all require different style transceiver cables, matching to the controller is critical. The ST-500 will work properly with any style transceiver cable. However, since cable grounding is accomplished at the host end of the cable, proper cable and host matching is critical.

The appendix explains in more detail the differences between the various versions. Cabletron can provide any transceiver cable you may require. If you are unsure of your needs, contact Cabletron for help.

The female end of the transceiver cable mates with the ST-500 15 Pin interface. The slide lock on the cable must be locked following attachment to the unit. (As a hint, since the transceiver cables weight may cause the slide lock assembly to fail, a good idea is to strain relief the transceiver cable to the coax cable about 6 inches from the transceiver).

Next, attach the male end of the cable to the 15 Pin connector on the host system.

IMPORTANT: It is wise to insure that the 15 Pin connector on the host system is grounded; and is grounded in a similar fashion as the transceiver cable. Failure to provide proper grounding will result in garbled packets, especially noticable on longer length packets.

Next, power up the system. The LANVIEW feature of the ST-500 should reflect the following lighting pattern:

With SQE (Heartbeat) Enabled:

Power LED on
SQE on
Transmit off unless host Transmits data
Receive off and on depending on network traffic
Collision off and on depending on collision occurrence on network and when host transmits data.

With SQE (Heartbeat) Disabled:

Power on
SQE off

Transmit off unless host transmits data
Receive off and on depending on network traffic
Collision off and on depending on collision occurrance on network.

The lighting patterns indicated above will mean that the connection to the Ethernet/IEEE 802.3 network has been accomplished and the host now has access to the network. Other lighting patterns displayed are discussed in the Troubleshooting segment of the manual.

IMPORTANT: The LEDs are intended to be an aid in troubleshooting and maintenance of the network. Please remember, these are simple LEDs. They are in no way a substitute for more sophisticated LAN Test and Troubleshooting equipment such as the Cabletron LAN-MD and TDR 5000. To properly install and maintain a network that runs at it's intended data rate, these more sophisticated test procedures are required.

HEARTBEAT (SQE) TEST

Heartbeat (SQE) is a test to insure that the collision presence circuit and path is working. This test is generated by the transceiver after it transmits a packet from the host. Since the collision circuitry is critical to the sound function of all CSMA/CD networks, the inclusion of this check is relevant.

The problem with heartbeat is that it is not part of the Ethernet Version 1.0 specification. Therefore, Version 1.0 equipment may not function with transceivers that generate the heartbeat signal.

Additionally, IEEE 802.3 specifications state that IEEE 802.3 compliant repeaters must not be attached to transceivers that generate heartbeat. (This has to do with a jam signal that prevents redundant collisions from occurring on the network).

Since there are circumstances where both styles of transceivers may be required, Cabletron has designed one unit that fits both needs. Additionally, a LED indicates whether the heartbeat signal is being generated to further reduce confusion.

It is important that the transceiver be configured to work with the Ethernet or IEEE 802.3 controller. Therefore, any confusion as to the configuration should be answered by the controller board user manual. (In many cases, Version 1.0 style equipment manuals will not mention the heartbeat (SQE) test, if the test is not mentioned a safe assumption would be to configure the transceiver such that heartbeat is not generated.

IMPORTANT: Use of heartbeat and non-heartbeat transceivers on the same network will have no effect on network performance. This test is strictly between the transceiver and host system, and has nothing to do with the network.

CONFIGURING THE HEARTBEAT (SQE) TEST

Remove the tap from the ST-500.

Look into the rectangle indent where the tap once was resident.

Inside the rectangle the user will notice a 15 position receptical. Six of the positions contain metal contacts. Turn the ST-500 so that the bulk of the six contacts fall on the right hand side of the unit.

To configure heartbeat (SQE) test on, move the jumper to the two contacts located to the right hand side of the three contacts which are located adjacent to each other.

To configure heartbeat (SQE) test off, move the jumper to the two contacts located on the left hand side of the three contacts located adjacent to each other.

Reconnect transceiver and tap.

Reconnect transceiver cable.

Once power is on at the host system, the SQE light will be lit for all transceivers with heartbeat enabled. Conversely, the LED will not be lit for all transceivers which have heartbeat disabled.

If the SQE light does not match the transceiver type, the configuration steps must be read again and the transceiver reconfigured.

JUMPER LOCATION

FOR SQE "ON"

FOR SQE "OFF"
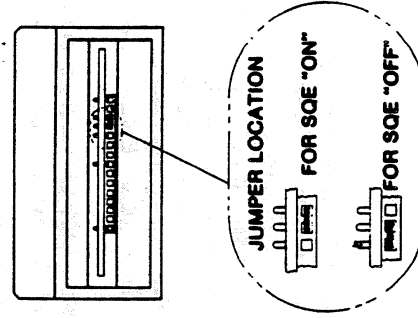
APPENDIX

Glossary of Terms

Cheapernet - see Thin-net

Collision detection - see CSMA/CD

Controller - A device which acts as the electrical and logical interface between a host system and a local area network. Often it is a plug-in addition to the equipment and involves software as well as hardware in standard Ethernet, the controller is attached to the network bus by way of a transceiver. For Thin-net, the controller and transceiver are usually combined.

CSMA/CD - Carrier Sense Multiple Access/Collision Detect. This means of access control in Ethernet.

Host System - Any device which acts as the source of, or a destination for, data; for example a printer, a computer terminal, or a computer.

IEEE, IEEE 802.3 - IEEE is the Institution of Electrical and Electronic Engineers, a professional body in the USA one of whose technical committees, known as IEEE 802, is a major focus of activity in the preparation of standards for local area networks.

Packet - A series of bits forming a block into which all, or part, of a data message is put to be sent through a network. Each packet has a defined format, with some additional bits forming a head preceding the data and a tail following it; these carry information which the network needs to know about the packet, including its destination and source. The packets are formed by the controller in the sending Host system and the data is extracted and reassembled by the controller at the receiving end.

Repeater - In Ethernet, a device for connecting one coaxial segment to another within the same LAN. The repeater transmits signals both ways between the segments, and has appropriate procedures for dealing with possible collisions and any fault conditions which may occur.

Thin-net - A low cost implementation of Ethernet intended principally for connecting together clusters of personal computers.

Transceiver - A combined transmitter and receiver. An essential element of all LANs, its function is required at each node of the network. In Ethernet, the transceiver transmits data packets from the controller onto the bus, receives packets from the bus and passes them on to the controller, and detects collisions. Ethernet transceivers are switched off when their associated host is not in use, without affecting the operation of the network as a whole.

USE OF LANVIEW

This section discusses LANVIEW LED conditions that should not appear on a properly functioning network. LANVIEW is a simplistic method of detecting certain network and node occurrences. The following is an attempt to help users determine some of the occurrances based on LANVIEW LED patterns.

IMPORTANT: LANVIEW is intended to be an aid in the troubleshooting and maintenance of a network. These are simple LEDs, they are in no way a substitute for more sophisticated LAN test and troubleshooting equipment such as the LAN-MD and TDR 5000. To properly install and maintain a network that runs at it's intended data rate these more sophisticated test procedures are required.

For purposes of this discussion, SQE LED will be eliminated. This LED will be on when SQE is enabled and off when the test is disabled.

Condition #1 No LANVIEW LEDs on

Probable Cause
- Check power on at host
- Check proper connection via transceiver cable
- Check power pair of transceiver cable

Condition #2   Power on
                      Transmit off
                      Receive on (steady)
                      Collision on (steady)

Probable Cause

-Transceiver tap not making contact with center conductor on coax (open).
— TDR 5000 at end of coax with E-Net button depressed.
(All other transceivers should have collision on (steady).

Condition #3   Power on
                      Transmit off
                      Receive off
                      Collision on

- TDR 5000 on network with E-Net button depressed

Condition #4   Power on
                      Transmit flashing (Simultaneously)
                      Receive flashing (Simultaneously)
                      Collision flashing (Simultaneously)

- Open in coax
-Intermittent in tap, check connection (Do other transmitting stations show same condition? If yes, network problem; if no, node problem).
- Check transceiver cable is proper cable used, if so if cable paired properly.
-Normal LANVIEW status if SQE is enabled and the host is transmitting.

	V1.0	V2.0	IEEE 802.3
Transceiver Cable	(3) 22 AWG pairs (1) 20 AWG Inner & Outer shield common at backshell ands pin 1	(4) 20 AWG pairs Inner & Outer shield common at backshell and pin 1	(4) 20 AWG pairs Inner & Outer shield isolated from each other Outer shield at backshell, inside at pin 4 Indented Male connector for better electrical connection.
Transceiver (SQE)	Full Step No Heartbeat	Half step Heartbeat	Half Step Heartbeat
Grounding	Pin 1	Pin 1	Pin 1, 4, 11 & 14 Ground indents on male connector, Jabber Latching
Repeater	No requirements	No requirements	Redundant Collision Protection using Jam sequence, Segments excessive collision segment from network.
Major Vendors who Support Standards	Xerox, U-B Gould, Harris CABLETRON	DEC CABLETRON	U-B, 3Com, DEC Hewlett Packard Micom-Interian Xerox, Intergraph CABLETRON

Condition #5

Power on
Transmit Flashing
Receive off or on
Collision off

- Coax cable shorted
- Transceiver tap shorted

Condition #6

Power on
Transmit flashing
Receive on/flashing or off
Collision on steady

- Collision detector on - controller not properly deferring (condition cause by TDR 5000 with E-Net button depressed).
- Collision path via transceiver cable is broken.

NOTE: All these conditions described require a host system be attached and transmitting data packets. The Cabletron LAN-MD is suggested for use as a node and subsequently for test of suspect transceivers, transceiver cables, repeaters and multiport transceiver units.

NOTE: A simple test to determine node vs network problems is to observe LANVIEW occurrances on more than one ST-500 transceiver. Similar indications at more than one station point towards a network problem. Whereas, observations at only one station indicate a node problem. This is strictly a rule of thumb and may not apply to all cases.

DIFFERENCES BETWEEN STANDARDS

As mentioned throughout this manual, not all 'Ethernet and IEEE 802.3" standards are the same. In fact, in some cases, there is enough difference to cause problems.

In a network environment an Ethernet Version 1.0 and an IEEE 802.3 node can coexist and communicate properly on a network. The important link is the overall transceiver to node integrity. The following will display some differences between standards. Any questions, please contact Cabletron.